mLearn2010

mobile learning

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Conference Proceedings

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Foreword

Dr Matthew Montebello, PhD

On behalf of the organizing committee for mLearn2010, I would like to welcome you to Malta and to the 9th World Conference on Mobile and Contextual Learning. Whilst I would like to thank all of you for your insightful and engaging contributions, I hope that you will find this conference an opportunity for networking and for sharing knowledge, resources and interesting project ideas.

Throughout the years, mLearn, through the commitment and work by the International Association for Mobile Learning (IAmLearn) has established itself firmly as a significant mark in mobile and contextual learning where some ground-breaking and pioneering work has been presented to the community.

This year we have also tried to bring together the various aspects which make up the basic elements of Education within a mobile context. The following objectives were set to guide the structure for mLearn 2010.

- To promote the development of mobile learning;
- To stimulate critical debate on theories, approaches, principles & applications of mobile learning;
- To share local & international developments, experiences & lessons learned;
- To promote networking & business opportunity development;
- To encourage the study & implementation of mobile applications in teaching &learning;
- To stimulate & assist personal professional development & the development of new skills for educators;
- To provide a forum for education & knowledge transfer;
- To facilitate dialogue, & networking between diverse cultures for the best use of emerging technologies;
- To bring together providers of technology & services with educators and instructional designers.

The main theme has focused mostly on the future of mobile and contextual learning and increased accessibility for all users in terms of applications, future directions, technologies and user-centric developments.

Applications; focusing more on the mobile society, giving an overview of applications for education and knowledge acquisition and sharing, in terms of the community and at the industry level;

Future directions presents current research and development in the area of context modelling and management, giving an overview of embedded learning, mobile learning for all, with attention to assistive technologies.

Technologies has been investigated in terms of devices, technologies and standards for enhanced context-awareness, context-management, ambient-intelligence for education, curiosity-led learning, knowledge acquisition, accessibility and interoperability, as well as ubiquitous learning;

User-centric developments focuses on a number of principles and theories related to mobile pedagogy for formal, informal and lifelong learning as well as training practices; users are not only seen in terms of developers and learning technologists, but also in terms of industry supplying the technology and the general members of the community.

On all these fronts we need to take into consideration the requirements of the various stakeholders and move towards offering an interoperable borderless service which is tailored to the individuals' needs. Together through increased collaboration we can work towards establishing international standards, policies and guidelines which will help severe the existing boundaries and overcome the limitations of the technology for an investment into a global, 'open' knowledge society. We hope that you will find the various contributions enclosed useful. I am sure, as all of you, that the ideas enclosed herein, have the potential to grow into a dynamic program, which aims to harness the full potential of the technologies for today's digital society.

Thank you,

Matthew Montebello, PhD
Conference Chair,
Faculty of ICT, University of Malta

Keynote Speakers

Prof. Agnes Kukulska Hulme

Title: Conversations En Route to Learning

Abstract: It is not what we learn in conversation that enriches us. It is the elation that comes of swift contact with tingling currents of thought, observed the essayist Agnes Repplier many decades ago. In recent years, technologies and media for swiftly getting in touch and maintaining contact with others have multiplied. Talking to oneself has become more socially acceptable, and chatting online to strangers is interpreted as a sign of self-direction and peer learning as well as a potentially dangerous pursuit. Opportunities for elation abound. How do the new ways of communicating enrich learning, and what specifically does mobile technology offer? This presentation will give a guided tour of mobile communication in the early 21st century, drawing on learners' own accounts of how and why they talk, chat, gossip, banter, canvass, argue, debate and converse on their way to learning.

Professor Kukulska-Hulme is a Professor and Director of the Next Generation Distance Learning research programme, at the Institute of Educational Technology at The Open University

Mr Andy Goff

Title: Augmented Reality for Learning

Abstract: Find out about the latest and most compelling advances in mobile learning with a demo of SONY PlayStation Portable and Second Sight. Second Sight works with SONY PSP allowing students to access media rich content ... images, audio, video and 3D objects, greatly enhancing the learning experience. Second Sight enables teachers to blend the use of their established text books, display materials and audio visual content in a way that has not been easy to deploy in the classroom before. Our workshop, as well as focusing on Second Sight and SONY PSP will also cover advances in mobile technology including mobile phones, i-Pod and Nintendo DS. We will also touch on how to maximise the use of this emerging technology and how to find and create compelling content.

Mr Goff is Education Director for ConnectED; Exclusive UK Distributors in education & training for SONY PlayStation and SONY Virtuoso

Prof. Mohammed Ally

Title: Mobile learning to transform the delivery of education: Are we ready?

Abstract: As students and citizens of countries acquire mobile technology, they will demand that they learn using the technology. Owners of mobile technology already use technology for entertainment, to socialize, conduct everyday business, and access formation. They will ask the question "Why cannot we learn using the mobile technology?" Educators will have to design learning materials for access by learners in their own contexts and at their convenience. The technology will have to adapt the learning materials to the learner needs and the context in which the learner is located. The educator will have to provide support to learners using mobile technology. The use of mobile technology will allow educators to transform the delivery of education for the 21st century. The question is "Are we ready for this transformation?"

Dr Mohamed Ally is the Director of the Centre for Distance Education and Professor in Distance Education at Athabasca University, Canada

Mr Inaki Berroeta

Title: How Smartphones and Data Technologies enable M-Learning

Abstract: Mobile Communications today is of utmost importance. Smartphones, apps and high-speed data networks fundamentally change the user’s mobile experience and the way we look at information. Mobile Communications has now developed beyond the traditional activity of phoning and entered into new challenging dimensions which enable people to enhance their lives. Vodafone Malta is supporting M-learning initiatives in Malta, because it believes in innovation and in providing the adequate space to new ideas and concepts. Vodafone Malta is supporting a number of initiatives launched by the University of Malta to further motivate students in their education experience. Our services are shaped around the challenges Malta is facing based on our three main pillars, Speed, Simplicity and Trust. We believe that together with all our main stakeholders, we can truly shape the Maltese Society.

Mr Inaki Berroeta is currently CEO of Vodafone Malta Limited

Applications

Full Papers

MobiMaths: An approach to utilising smartphones in teaching mathematics

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Abstract
The teaching of mathematics at second level is well known to be a challenging issue. An overemphasis on didactic teaching, lack of encouragement to explore possible alternative solutions to problems, an overemphasis on procedure and the separation of mathematical procedures from real world problems are just some of the factors which are put forward as contributing to the difficulties in math education. Through its inherent ability to support collaboration, and contextualised learning, mobile technology offers the potential to address at least some of the issues in mathematics education. This paper describes the approach we are following to create a set of tools, learning applications and teacher supports, which exploit smartphone technology to aid in the teaching and learning of mathematics. The work is underpinned by a social constructivist pedagogy with an emphasis on collaborative problem solving and the contextualisation of learning. This paper discusses issues in mathematics education before going on to describe the broad approach being followed in our research. The underlying technical architecture is described along with the first two activities we have developed. The preliminary results from a user evaluation study are reported upon.

Keywords
mathematics; smartphones; contextualised learning.

1. INTRODUCTION

There is considerable disquiet that students leave secondary school systems with a fragmented view of mathematics and are unable to put their knowledge to constructive use in the workplace (Goos, 2004; Goss, 2009; Grossman Jr, 2001). It is argued that a number of related factors are responsible for this including: an overemphasis on didactic teaching, in which the teacher is commonly seen by students as an absolute authority on the subject whose role is to transmit the knowledge that is needed to master the problem so that students are discouraged from exploring possible alternative solutions or finding their own (Conway & Sloane, 2005; Muis, 2004); a behaviourist approach to learning in which complex problems are commonly presented as aggregations of one-dimensional tasks which are then mastered discreetly; an overemphasis on procedure, in which mathematics is presented as a 'highly fragmented set of rules and procedures rather than a complex highly interrelated conceptual discipline' (Garofalo, 1989). Most importantly from the point of view of this work is the decontextualised way in which mathematics is often taught. Students rarely are exposed to real world data, situations or problems and have extreme difficulty relating the de-contextualised material they are exposed to any aspect of their lives.

Mobile technology and smartphones in particular, offer a means whereby at least some of the issues in mathematics education can be addressed. The potential for mobile technology to support collaborative, constructivist, contextualised learning is well documented in the literature both in terms of conceptual frameworks (Kukulska-Hulme A., Sharples M., Milrad, Arnedillo-Sánchez I., & Vavoula G., 2009; Patten B., Arnedillo-Sánchez I., & Tangney B., 2006; Sharples M. (Ed), 2006) and practical examples of prototypes in action – for example (Facer, 2004) and (Wijers M., Jonker V., & Kerstens K., 2008). In particular smartphone capabilities in terms of location awareness; peer to peer communication between devices; anytime anywhere internet access; accelerometers; touch screens; image and video capabilities; and data capture mean they can be used as the basis for scaffolded learning scenarios which open up the exploration of mathematical concepts in innovative ways.

For example, and as described in the body of this paper, the accelerometer in a smartphone can be used to create a tool which measures an angle of elevation. This allows a series of activities to be designed to measure the height of a building or structure. The extent to which the learning is scaffolded is up to the teacher and can range from giving detailed step by step instructions to following a much more open discovery learning approach. With little or no prompting learners should realise that by measuring the angle of elevation, and the horizontal distance to the base of the structure in question, the TAN function can used to determine the height. The exercise becomes even more mathematically interesting when learners are encouraged to estimate distances, heights and angles before measuring them and to compare these to the actual values measured. Issues to do with margins of error in measurement can be explored as well as means of calibrating their answers against known heights. A second activity described below is based upon manipulating Cuisenaire Rods on the screen of the smartphone in order to engage in a learning activity concerned with fractions. The activity can be made collaborative by configuring the initial allocation of rods to learners so that they are required to exchange rods with each order in order to arrive at a solution.

Both of these activities form the basis for rich contextualised, collaborative, constructivist learning experiences which we argue address many of the concerns of mathematics educators. Our research goal is not to create sample tools and scenarios but rather to produce a set of activities which cover a substantial block of curricular material in a comprehensive and cohesive manner so that teachers can be facilitated in making extensive use of mobile learning in a pragmatic way in their day to day teaching. To this end we are systematically working going through Grade 7 of 2006 NCTM Principles and Standards for School Mathematics (NCTM, 2006) in order to devise a set of suitable learning activities which address the main areas of: Data Analysis; Measurement and Geometry; Number, Operations and Algebra.

2. Issues in Mathematics Education

Internationally there is growing concern about the participation levels and success rates within the study of mathematics across the developed world (Noyes & Sealey, 2009). No single factor is responsible for this, rather a combination of interlinked factors are at play some of which have been mentioned earlier. Other factors include curriculum and assessment constraints (Entwistle, 2000); teaching standards and methodologies (Lyons, Lynch, Close, Sheerin, & Boland, 2003) and students perceptions and attitudes (Brown, Brown, & Bibby, 2008; Burghes & Hindle, 2004).

In particular mathematics curricula tend to concentrate on the abstract concepts of mathematics rather than application or discover of concepts. This leads to students' perception of mathematics to be an arid subject irrelevant to the practical world outside the classroom (Breen, 2009; Burghes & Hindle, 2004; Smith, 2004). (Greeno & Collins, 2008) argue that the most fundamental problem of the mathematics curriculum in the US is that students learn a large volume of information with practically no understanding of how that information may be used in the 'real world'. They concentrate upon abstract concepts and place emphasis on procedural drills rather than concrete application. This type of curriculum is assessed in a format which tends to test substantial volumes of factual recall and the use of standard algorithms rather than understanding. This in turn impacts upon the way in which mathematics teachers approach their teaching (Brown et al., 2008).

(Nardi & Steward, 2003) also identify a "mystification through reduction" effect whereby teachers attempt to make mathematics simpler by reducing it to a list of rules. With the emphasis on modus operandi rather than its application, this notion of mathematics teaching is in stark contrast to teaching higher order thinking skills where students are encouraged to apply methods and concepts to situations that were previously unfamiliar to them (Donovan & Bransford, 2005).

By not highlighting the practical applications of mathematics within mathematics education in the curriculum, teaching methods and assessment, students are not challenged to develop higher order thinking skills. Thus students often learn mathematics without being able to solve problems in 'real world' situations (Schoenfeld, 1988). According to (Boaler, 1993) attempts to address this failing by introducing contextualised learning have had limited success for a number of reasons. Many of the 'real world' problems students come into contact with derive from textbooks which create pseudo-real-world problems that require students to ignore facts pertinent to the real life version of the task. Therefore they are 'school problems with a thin veneer of real world' (Boaler, 1993, p.4). Often the contextualised problems are sourced from the adult world rather than that of the students, impacting on the students' interest in solving the problem. This runs contrary to Piaget's argument (Piaget, 1958) that individuals construct new knowledge on the basis of their interest. If there is an over emphasis on the 'described situation' within the textbook as a method of contextualising mathematics rather than creating learning scenarios that are contextually realistic, interesting and of educational benefit, the use of contextualised learning becomes futile.

2.1 Mobile Technology and Mathematics Education

Many digital tools produced for mathematics education are essentially electronic versions of textbooks, drill and practice sometimes disguised as games (Bottino & Kynigos, 2009).

To date most of the mathematics learning applications for smartphones are versions of applications, or are at least very similar in style, to ones which are available for desktops. Puzzles and games are popular as well as graphic calculators. For example, many mathematics orientated "apps" on the Android Market are geared towards drill and practice of number and operation and are very similar in content and function, e.g. *ChoiceMath*, *MathPractice* and *MathSkill*. These "apps" are typically geared towards a single user and have no element of context or collaboration with other users. There are a small number of "apps" which are geared towards data collection – for example *TennisMath* allows users record events during a tennis match and then output a detailed analysis of the data collected. A number of "apps" for mobile phones such as *Pocket Autograph* and *Maths4Mobile* replicate the function of a graphing calculator on a keypad phone and have not been aimed at smartphones. On the other hand *TouchMaths* is a collection of mathematical tools which has been produced specifically for touchscreen phones but it assumes a high level of mathematical understanding by the user.

By and large smartphone "apps" for mathematics do not fully exploit the affordances of mobile devices to support contextualised, collaborative, constructivist learning nor do they attempt to explore the contexts in which learning takes place - the later being of crucial significance given the concern about the decontextualised nature of math learning.

More interestingly (Wijers M. et al., 2008) describe an interactive location based game which explores the construction and deconstruction of quadrilaterals in a hybrid virtual/real-world space. They follow the Realistic Mathematics Education philosophy (Gravemeijer K.P.E., 1994), in which "learning activities should be 'experientially' real", and in which social interaction is a key component of the learning experience. In their case this is achieved by requiring the learners to navigate in the physical space in order to construct and de-construct geometric shapes in an overlaid virtual world.

A hybrid approach made up of a combination of a location specific learning experience followed up by in-class activities is advocated by Spikol & Milrad (Spikol D. & Milrad M., 2009). In their case students use a mobile device to assist in measuring and estimating the height, area and volume of buildings as part of a data gathering exercise and then in-class use tools such as Sketch Up to design their own buildings. Not only does the learning activity integrate in-class and out-of-class learning it is also a good example of a technology supported cross curricula learning activity which helps to show the relevance of mathematics.

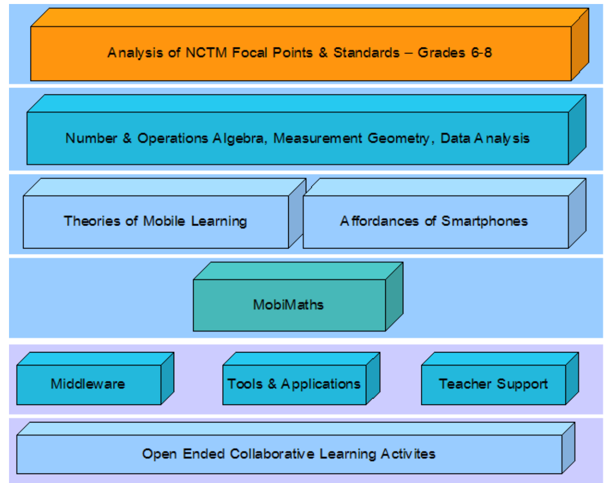

Figure 1: The MobiMaths Approach

Of the applications described previously MobiMaths is closest in spirit to the work of (Wijers M. et al., 2008) and (Spikol D. & Milrad M., 2009). We follow a broadly social constructivist pedagogy to mobile learning (Patten B. et al., 2006). In order to overcome the issues in mathematics education identified in the literature tools, applications and learning activities should: encourage learning and problem solving activities which occur (where possible) in real-life contexts; take place in an environment which is rich in information; involve performing authentic tasks in ill-structured domains; involve interactions with others. Finally there should be an emphasis on learning processes rather than solutions.

3. MobiMaths

We argue that it is time for Mobile Learning to move beyond the development of innovative prototype applications and activities which make for engaging one-off (albeit sometimes of long duration) learning experiences. For mobile learning to be successfully integrated into the classroom in any meaningful large scale fashion it must be applicable across a number of elements of the curriculum and come with an appropriate amount of support for the teacher so that they can not only see the benefits of mobile learning but also a clear path to how they can incorporate it into their daily classroom practice. Because of its widespread applicability, among a large set of teachers, we have chosen to focus on Grade 7 of the USA NCTM Principles and Standards for School Mathematics and the Curriculum Focal Points (NCTM, 2006). This has given rise to a focus on the areas of: Data Analysis; Measurement and Geometry; Number, Operations and Algebra. We are working through each of these areas to create learning activities according to the pedagogical underpinnings outlined below.

MobiMaths (Tangney B. et al., 2009) aims to provide an integrated toolkit encompassing all aspects from hardware through to lesson plans. From the hardware perspective learners will be provided with smartphones which can communicate with each other and with the teacher's console machine. The toolkit will include a range of neutral tools (Somekh, 1997) which can be applied broadly across the curriculum (e.g. an in-class voting response system) and a range of "Mindtool" applications (Jonassen, 2006) which are purpose defined by the curriculum and serve to amplify conceptual understanding, extend thinking and enhance problem solving (e.g. the Cuisenaire Rod application for fraction addition described below).

Using these tools and applications teachers are free to create innovative learning activities as suits their approach to teaching. MobiMaths support for teachers will also include a detailed set of activity sheets which will correlate to keys skills and topics within the relevant curricular area. Each activity sheet will also provide at least one open ended "challenge" to engage learners in solution strategy development and mathematical reasoning across a wider curriculum area.

We do not underestimate the issues to do with technical maintenance of phones and school policies on phone usage and ownership. Such issues are outside the scope of this paper but we assume that smartphones will be allocated to students (or groups of students) for at least the duration of the learning activity. Schools may follow schemes very similar to those already adopted to manage student laptops with each student having their own smartphone or the teacher may have access to a mobile cart of charged phones which are given to students for the duration of a learning activity.

Finally we are following an interdisciplinary design methodology with the team being made up of software engineers, educational technology researchers and experienced maths teachers. The core team is augmented with graphics design expertise as needed. An incremental prototyping approach is being followed. All tools and applications are being tested in authentic school settings with feedback flowing back through the design and prototyping process as appropriate.

4. Technical Architecture

This technical architecture is depicted in Figure 2. A four layered architecture separates core middleware functionality from behavior specific components.

The platform abstraction layer is the fundamental layer that provides essential device-specific functionalities. These include sensor readings, (e.g., GPS, accelerometer and compass), communication, (e.g., access to Wifi and 3G) and basic GUI functionality. Although we are currently developing for Android phones[1] this layer facilitates the porting of the educational activities to a variety of smartphone devices by providing abstractions from device-specific implementations.

The middleware layer implements generic functionality such as group communication primitives, GUI support, activity coordination, persistent storage, location determination and access to sensors.

Communication is crucial to enable collaborative problem solving. MobiMaths communication is web service based with the service residing on a remote web server accessed via the hypertext transfer protocol (HTTP). MobiMaths web services use Apache Axis technology to generate service descriptions using the Web Services Description Language (WSDL) and to generate appropriate Simple Object Access Protocol (SOAP) responses to client requests. These XML based messages are sent back and forth between the smartphones and the server. KSoap is a SOAP web service client library for constrained Java environments such as mobile phones. Requests are generated on the device based on application and tool requirements. The MobiMaths server services client requests and generates SOAP responses to return the required information. The SOAP response is then parsed by the KSoap client on the smartphone.

The component layer contains a set of components that provide functionality used in the development of MobiMaths applications. Each component provides a specific behaviour e.g., messaging, group management, etc. The group management component allows for the assignment of students into groups and the matching of groups with tasks. The messaging component provides messaging functionality within learning applications using communication functionality provided by communication primitives in the middleware layer. Above the component layer, the application layer includes MobiMaths applications and tools. Each application draws on behaviour provided by the lower layers to create applications supporting curriculum based activities. Each application is specific to a learning activity and will contain data and an application-specific GUI.

A teacher management system (TMS) enables teachers to manage and monitor learning activities. The management component is used to organise students into appropriate groups. Application specific data is generated by the teacher and pushed to student devices. This allows for varying levels of difficulty according to student ability. The TMS's other primary role is monitoring. On completion of a learning activity students send an acknowledgment of completion including any application specific results and metrics. These are recorded and can be accessed via the TMS to monitor progress and to customise future activities for a particular student.

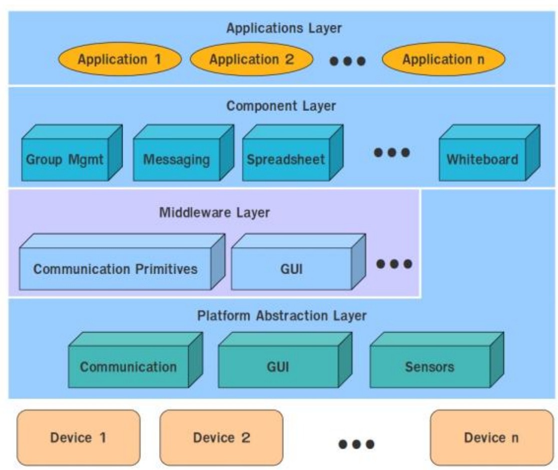

Figure 2: MobiMaths Technical Architecture

[1] The Android operating system is managed by the Open Handset Alliance, a consortium of 65 hardware, software, and telecom organisations and is currently used by various handset manufacturers including Ericsson, Motorolla, Samsung and Google.

5. Initial Tools and Applications

A sample application and tool are described below, the first for trigonometry and the second for fractions. They show how the toolkit can be used in different ways to support different aspects of the curriculum and hence meet the objectives outlined previously.

5.1 Angle Tool

The Angle Tool uses the phone's accelerometer to produce a visual readout of the angle at which the smartphone is being held. The tool displays the angle of elevation of the device and records that reading on user instruction, i.e. by tapping the screen. A running average of the previous five recorded angle readings is automatically maintained.

Learning activities based around the Angle Tool are mapped to the geometry and trigonometry section of the curriculum. One of the many criticisms of trigonometry is that it is taught in a context free fashion which leads to students having problems applying concepts to everyday experiences. Activities based upon using the Angle Tool facilitate the introduction of context into students' learning by having them apply theory to real world environments, situations and scenarios.

In the simplest case students can be given a task to measure the height of a nearby structure. Unlike many problems that students encounter in text books, there are no sub-steps for the posed problems to act as "marker points" for finding the right answer. It is envisioned that students develop their own sub steps, e.g. measuring the distance from the structure to the point of angle measurement, measuring from a number of different distances to calculate an average, comparing estimations with calculated answers.

To support teachers a detailed lesson plan is provided which explains the use of the tool and maps out clearly where in the curriculum it can be used. A number of scaffolding activities are also suggested to help promote discussion and reasoning among students. These also encourage students to consider the real world applications of the tool and how the calculated data could be used.

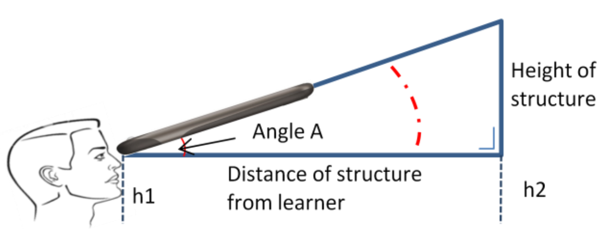

Figure 3: How to measure height

5.2 Cuisenaire Rods

Cuisenaire Rods - sometimes known as "Algebricks" or "Integer Bars" - are named after Georges Cuisenaire and were made popular as a tool for teaching fractions by Caleb Gattegno. The rods consist of rectangles of different colour and length which represent different fraction values and they can be used to teach the basic concepts of fraction addition, subtraction and equivalence.

We have developed an application to explore the addition of fractions. The activities which use this application also promote the development of reasoning, estimation, communication, and collaboration. Learners receive a number of fractions that are displayed as coloured rods on the phone screen. The challenge is to fill the empty unit space with some combination of the rods they have received. To avoid learners adopting a 'guess and test' strategy, both the time taken to complete the challenge and the number of moves made are recorded. The complexity of the activity increases as students are required to use a greater number of rods to fill the unit space.

Rods can be traded by selecting "Swap Rod" from the touchscreen menu, choosing the destination player and touching the rod to trade. This generates a web service request to send the chosen rod to the server. This rod is then held on the server and sent to the destination device. When a learner completes the activity (by filling the unit space) they generate a request that sends an acknowledgment of solution to the server with the number of moves, number of swaps involved and the time taken.

Collaborative learning experiences via paired or larger groups can be organised by configuring the allocation of rods to learners so that in order to fill the unit space on their phones learners must "trade" or "swap" with other players to acquire the correct solution set. Skills of estimation and reasoning are promoted and learners must communicate using the appropriate mathematical language and justify how a "trade" can benefit both parties involved.

Figure 4: Screenshot showing sample set of rods

The teacher can parameterize the algorithm used to create the sets of rods given to each learner and the overall level of difficulty of the activity can also be controlled.

6. User Study

An initial exploratory evaluation of an activity using the Angle Tool has been carried out and while the size of the study is too small to draw any substantive conclusions the initial findings are positive. A class of 24 second level students, working in 6 groups of 4, used the tool in an exercise to measure the heights of 3 structures in their school – a school building and sets of floodlights and goalposts on the sports field. The activity took place over 3 consecutive 40 minute classes on a Friday afternoon followed by a reflection and feedback session in a single 40 minute period on the following Monday. During this time students also filled in a post activity questionnaire.

As is typical in one off interventions such as this the participants found the experience engaging and enjoyed the collaborative aspect. In the post activity questionnaire the following attitudes were reported: 81% of the students found the tool easy to use; 62% said that the activity changed their ideas on trigonometry (in a positive way) with the remaining 38% being neutral; 85% reported that the activity made trigonometry easier to understand; 80% said they felt the activity aided in establishing concepts that the teacher had covered in class; 90% reported that they would like to use more of these types of activities in learning about mathematics. The students did however find the somewhat open ended specification of the task challenging. Students were asked to justify the approach to solving the task which they adopted and were not given readymade diagrams to follow. As one student reported "*the hardest part was working out the way you had to do it....*". They were also asked to estimate all readings and measurements before they took them and to estimate the heights of the structures before they calculated them. The later yielded some interesting results which are very much in keeping with the concerns about mathematics education raised earlier. Initial estimates of heights were off by as much as 170% (estimated 30m actual height 11m). More worryingly some groups did not connect their calculated height for one structure to their estimation of the (not too dissimilar) height of the next structure. Equally so some groups ignored the discrepancies between their estimated and calculated heights rather than probing further to see in which the error was made. The teacher was able to pick up on these discrepancies and explore students' grasp of estimation and the significance of number in the post activity reflective session.

While the study is too small to draw any definitive conclusions it does indicate that suitably constructed and scaffolded learning experiences along the lines proposed could lead to richer in class conversation about mathematical concepts and help the learners achieve a deeper engagement with and understanding of the topics in question.

7. Current Studies and Future Work

At the time of writing we are continuing to implement the Technical Architecture. We are also working through Grade 7 of the "NCTM Principles and Standards for School Mathematics and the Curriculum Focal Points" to devise suitable learning activities so that we can build the applications and tools needed support those activities. As new tools, applications and activities become available they will be tested by students in local schools.

Although our evaluation is still at an early stage we argue that for mobile learning to be of real benefit in schools it should be used to support learning activities which are integrated into the curriculum. Mobile technology is ideally suited to support collaborative and contextualised learning activities but the design of these to be relevant to the curriculum is not easy. For both of these reasons extensive support, in the form of both detailed lesson plans and ideas for open ended activities, must be provided to scaffold the teacher in the adoption of both sophisticated technology and potentially unfamiliar teaching and learning strategies.

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Game Play Time and Learning Outcomes of Boys and Girls in a Social Studies Mobile Game-Based Learning Curriculum

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Abstract

In this paper, we report on the enactment of an innovative social studies intervention program based on the *Statecraft X* game-based curriculum. This curriculum involved 41 ninth graders, 17 boys and 24 girls, using a mobile learning game *Statecraft X* on Apple iPhones to enact governorship in the game world of Velar. This paper seeks to investigate whether this mobile game-based curriculum favors boys rather than girls. The data suggest that boys spent significantly more time playing the *Statecraft X* mobile game compared to girls. However, there were no significant differences in their scores in an essay question that assessed their learning of governorship in terms of criteria of relevance of content, perspective, and personal voice. There was also no significant correlation between game play time and essay scores. Thus, the results indicate that boys are not favored in the *Statecraft X* mobile game-base curriculum although they were more engaged in the game play. We will discuss the factors that gave rise to these results.

Keywords

Mobile, game, gender, content, perspective, voice

1. INTRODUCTION

Boys are thought to have an unfair advantage in game-based learning environments because gaming is established as a male activity and more males spend more time playing computer games than females (Bertozzi & Lee 2007; Buchman & Funk 1996; Chou & Tsai 2007; Green & McNeese 2008; Solomonidou & Mitsaki 2009, Winn & Heeter 2009). In a review of digital games, Dickey (2006) noted that game content traditionally suited males better, and that there was more male access and control over public leisure spaces such as video arcades, pubs, and bars, and domestic spaces such as television sets and computers in the living room in the past. Marsh (2010) also underscored the privileging of boys' interests in the selection of internet sites by educators to promote learning. Pre-school girls were offered access to websites that did not correspond to their stated interests and preferences. Marsh (2010) noted that educators did not adopt technologies such as dance mats and karaoke machines and digital literacy practices adopted by girls in curriculum planning. Thus, the fear is that girls will not perform as well as boys in a game-based learning environment because they have less access and control over gaming spaces and that non-educational game content has traditionally catered to male interests. However, Papasterigou (2009) investigated the learning effectiveness of a educational computer game for learning computer memory concepts in 88 16- to 17-year-old students in two Greek high schools and found that there were no significant differences in learning gains between boys and girls despite boys' greater involvement and experience with computer gaming. Since the students in her study played the computer game in the school computer laboratories, she did not investigate the time spent in playing the specific computer game investigated. Her study did not involve a mobile game that may provide girls with more control over and access to computer games. With the proliferation of mobile learning in the work place and in schools (De Freitas & Griffiths 2008; Facer *et al.* 2004; Klopfer *et al*. 2005; Norris & Soloway 2009; Pachler 2010; Petrova & Li 2009; Sharples 2006; Squire & Jan 2007; Squire & Klopfer 2007), it becomes easier for games to be installed in mobile devices and males no longer have primary access to and control over public and domestic leisure spaces. Game content can be changed to cater to both male and female interests. Thus, girls may spend as much time as boys since game content is modified and they have more control over their game space. The present study thus addressed the following research questions:

(1) Are there gender differences in game play time if game content and game spaces were designed not to privilege males?

(2) Are there gender differences in game-based learning outcomes in favor of females if game content and game spaces were designed to be more balanced between males and females?

(3) Is there a significant correlation between game play time and learning outcomes?

2. METHODOLOGY

2.1 Participants

Seventeen boys and twenty-four girls participated in the present study. They were from a high-ability ninth-grade class in the Express Academic track. They were divided into two groups: Games 1 and 2. There were twenty-one students in Game 1 and twenty students in Game 2. Students in each game were assigned to four factions for game play: one all boys' faction (Dragon), one all girls' faction (Phoenix), and two mixed group factions (Griffin and Pegasus). One student was absent during the administration of the post-intervention survey.

Two female social studies teachers were involved in the study. The lead teacher observed a four-day pilot study which took place in October 2009 in the same school. In November 2009, the two teachers participated in a two-day professional development workshop with the research team. During the intervention period from 18 January to 3 February 2010, the first author also had discussions with the two teachers regarding lesson plans.

2.2 Materials

Statecraft X is a social studies mobile game designed for this study. It is based on principles of governance in the Social Studies curriculum for ninth-graders in Singapore. The four principles of governance found in the Singapore's ninth-grade Social Studies textbook are:

(1) Leadership is key;

(2) Anticipate change and stay relevant;

(3) Reward for work, and work for reward;

(4) A stake for everyone, opportunities for all.

At the start of the six one-hour lessons which took place during the intervention period of 18 January to 3 February 2010, each student was loaned an Apple iPhone with the *Statecraft X* game installed in it. In this multi-player strategy game, factions competed against one another to rule the fantasy kingdom of Velar populated by four races of sentient beings: humans, dwarfs, elves, and trolls. The back-story of the game is that King Topez of Velar passed away without leaving an heir, thus creating a power vacuum. Student governor-led political factions then had to look after their town people and try to take over the capital city in the kingdom. See Figure 1 for a screen shot of the *Statecraft X* game on an Apple iPhone.

Figure 1: Students checking on the well-being of their town people

There were two game objectives. The first objective was for each faction to consolidate its power and position by winning the trust of the towns assigned to them at the beginning of the game, of neutral towns, and also of towns belonging to other factions. Second, all factions must collaborate to ensure that the kingdom of Velar, survives in the face of attackers from other neighboring kingdoms.

During the intervention period, events involving the game world such as health epidemics, refugee influx, famine, and bandit attacks were triggered by the server. Therefore, in addition to developing towns under their control, student governors also had to cope with these events.

In addition to the *Statecraft X* game, teacher-facilitated activities (e.g., whole class discussion, group discussion, and student presentation), online blogs, and forums supported the learning of the *Statecraft X* curriculum. In the classroom, students were situated in Bellalonia. The teachers role-played as the grand sages of Bellalonia while students role-played as governors of Bellalonia. The third author created this fictional world as a non-threatening space for reflection of events that happened in the real and game worlds. Figure 2 situates the learner at the centre of the three worlds: game, fictional, and real. During in-class discussions and questions posted on the web portal, the first and third authors created questions to reflect on their governing practices in the game world of Velar, and on their knowledge of the real world so that they could solve problems in the fictional world of Bellalonia. At the beginning of the first lesson, the Grand Sages gave them a sheet of paper enumerating the problems student governors had to solve in Bellalonia: (1) high tax rate, (2) high unemployment rate, (3) high emigration, (4) low economic growth due to lack of resources and money, (5) political instability due to the death of the old king of Bellalonia, (6) malaria and tuberculosis health epidemics. The Grand Sages sent student governors to the game world of Velar where they faced challenges in governance so that they could become better governors.

The third author set up a web-portal situated in the fictional world of Bellalonia to provide a space for students to be informed of events happening in the game world of Velar and the fictional world of Bellalonia. The first author provided additional materials from the real world to be uploaded on the web-portal so that students could consider experiences that governors face in the real world countries. These readings provided students with additional perspectives of governance beyond the *Statecraft X* game and the ninth-grade social studies textbook.

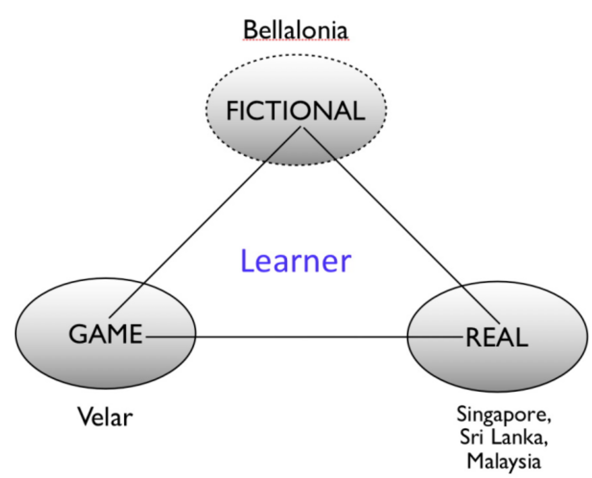

Figure 1: A play-between-worlds curriculum model

All the above materials were tied to the play-between-worlds curriculum model shown in Figure 2. By having the option to move from one world to another, students were not tied to the real world and the game world which were more finite in terms of governing practices. In the fictional world of Bellalonia, students could come up with infinite ways of solving challenges or imagining scenarios. This is more powerful because students could think of problems in potential scenarios and solutions to these problems.

2.3 Procedure

All lessons were video-recorded. In the lead teacher's classroom, one video camera recorded the general classroom, one camera each was focused on three groups in the classroom. In the other teacher's classroom, one video camera recorded classroom activities. During the first lesson, students were given an Apple iPhone with the game *Statecraft X* installed in it. The game designer of *Statecraft X* taught students how to use the game through a tutorial session of learning how to manage towns, trade, move from town to town, etc. Table 1 summarizes the sequence of in-class and out-of-class activities of the *Statecraft X* curriculum.

According to the following schedule that was worked out in consultation with the school, students could play during non-curriculum time: from 6 a.m. to 8 a.m. and from 2 p.m. to 10 p.m. on Mondays to Fridays, and from 6 a.m. to 11 p.m. on Saturdays. No game play was allowed on Sundays. Every hour, students were awarded a fixed number of action points that they could use for various player actions.

The first author administered a post-intervention survey at the end of the last lesson. She also administered an essay a few days after the last intervention lesson during a regular social studies class in the morning. She asked students to complete the essay in thirty minutes. The essay instruction was:

Imagine that you are running for an election to be a member of parliament and that you have to formulate policies to convince the citizens of your country that you are the best candidate. Justify your proposed policies by using examples from what you have learnt, what you have read, and your personal experiences.

The first (Rater A, female) and third authors (Rater B, male) were the assessors of the essays. Both held graduate degrees, had at least eight years of teaching experience in Singapore schools and were part of the *Statecraft X* research team. Rater A also had three years of experience in an improving teachers' assessment literacy project where she trained teachers to assess student work during assessment workshops based on a scoring guide and exemplars of student work. She also acted as an adjudicator during score resolution sessions when two teams of teachers gave different ratings to student work. Raters A and B assigned scores of levels 1 to 4 for the criteria of relevance of content, perspective, and voice to all 41 written scripts (see scoring guide in Appendix 1). Relevance refers to how relevant the policies proposed by a student were to the social and economic needs of the different segments of a country's population and whether the student had given examples from both traditional and non-traditional sources to support his or her policies. Perspective refers to whether a student could give multiple perspectives to the proposed policies and integrate them or whether he or she could only give the textbook perspective. Personal voice refers to the voice used by a student and whether it matched the situation, how authentic the voice was, whether opinions were well-defined and detailed, whether he or she communicated strong feelings and honest statements, and whether he or she showed that he or she cared for the topic.

Raters A and B then had a morning session of reviewing all scripts together to discuss a final score for each script. When there was a discrepancy, they compared the features of the student's script with the benchmark performance in the scoring guide together again and discussed why the student should be awarded a certain score. They considered any evidence that challenged the original scores and achieved a consensus score. They then assigned a final score or operational score for each criterion. Johnson et al. (2005) recommended the use of discussion to resolving discrepancies and improving score accuracy.

Table 1. Summary of activities

In-class activity	Out-of-class activity
Session 1: Game tutorial, whole class discussion	Game play, reflection blog
Session 2: Whole-class discussion, examination of four case studies in groups, student presentation	Game play, reflection blog, online forum, debate preparation
Session 3: Debate, whole-class discussion	Game play, reflection blog
Session 4: Whole-class discussion, gro planning of individual writing assignment	Game play, reflection blog
Session 5: Writing of individual assignment	Preparation for presentation
Session 6: Presentation of final assignment, post-intervention survey	-
Session 7: Written speech	-

2.4 Data sources and data analysis

The data sources used in this paper were the post-intervention survey and the written speech. Table 2 summarizes the data sources, dependent measures, and analysis strategies used to answer the three research questions of this paper. Levene's test was used to test the assumption of equal variances. To address the first research question of whether there were gender differences in the amount of time spent playing *Statecraft X* per week, a 2-tailed *t*-test was used on the time spent playing the game with gender as the independent variable.

Table 2. Alignment of research questions, data sources, dependant measures, and analysis strategies

Research question	Data source	Dependent measure	Analysis strategy
Are there gender differences in game play time?	Survey	Time spent per week in game play	2-tailed *t*-test
Are there gender differences in learning outcomes?	Written speech	Relevance score, perspective score, and voice score	2-tailed *t*-test
Is there a significant correlation between game play time and learning outcomes?	Survey, written speech	Time spent per week in game play, relevance score, perspective score, and voice score	2-tailed non-parametric Spearman correlation test

To address the second question of whether there were gender differences in learning outcomes, a 2-tailed *t*-test was conducted on the dependent variables of relevance of content, perspective, and personal voice.

Inter-rater exact and adjacent agreement rates were also calculated for the variables of relevance, perspective, and voice. For the scoring of essays, most agencies and educational studies generally accept scores which are at least adjacent (e.g., Brennan 1996; Penny 2003). To address the third question of whether there was a correlation between game play time and learning outcomes, a 2-tailed non-parametric Spearman correlation test was run on the variable of time spent playing *Statecraft X* with the variables relevance, perspective, and voice respectively.

3. RESULTS

3.1 Hours of Game Play Time per Week

Levene's test showed that the assumption that variances were equal was not supported, $F = 5.71$, $p = .02$ (see Table 3). Thus, we used the *t*-values for not assuming equal variances. As shown in Table 4, the results of the study indicate that boys (M= 19.20, SD = 15.25) spent significantly more time playing the game *Statecraft X* than girls ($M = 7.35$, $SD = 6.87$), $t = 2.76$, $p = .012$, $\alpha = .05$, 95% CI [3.34, 20.35]. The mean difference in game play time between boys and girls was 11.84. Figure 3 shows the distribution of game play time across boys and girls. The majority of the girls (75%) reported spending less than 10 hours per week playing *Statecraft X* compared to 31% of the boys. Except for one girl who reported spending 32 hours a week playing *Statecraft X*, the rest reported spending 15 or fewer hours a week in game play time. On the other hand, ten boys out of sixteen reported spending more than 15 hours a week in game play time. One boy even reported spending 62 hours a week in game play time.

Table 3. Levene's test for equal variances

	F	*p*
Game play time	5.71	.02
Relevance	.91	.35
Perspective	.91	.34
Voice	.35	.56

Table 4. Gender differences in hours of game play time per week

	Gender			
	Male (N = 16)	Female (N = 24)	*t*	*p*
Mean	19.20	7.35	2.92	.009
SD	15.25	6.87		

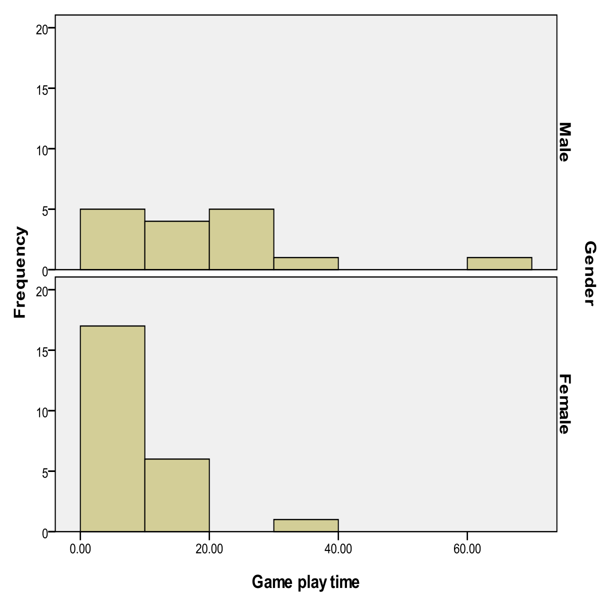

Figure 3: Distribution of game play time across boys and girls

3.2 Learning Outcomes

The reliability data for exact and adjacent agreement is shown in Table 5. As can be seen in Table 5, the percentages of exact and adjacent score agreement were 92%, 100%, and 78% for the essay criteria of relevance, perspective, and voice respectively.

Table 6 shows the descriptive statistics of boys and girls for learning outcomes. Levene's test indicates that the variances for relevance, perspective, and voice can be assumed to be equal (see Table 3). The *t*-values reported reflect that. The results of the present study suggest that there were no significant differences in learning outcomes between boys and girls (see Table 7).

Table 5. Exact and adjacent score agreement between raters A and B for relevance, perspective, and voice

Agreement	Relevance	Perspective	Voice
Exact	24	22	15
Adjacent	14	19	17
Exact and adjacent	38	41	32
% exact and adjacent	92%	100%	78%

First, the relevance scores of boys (*M* = 2.65, *SD* = 1.06) and girls (*M* = 2.58, *SD* = .83) were not significantly different, *t* (39) = .22, *p* = .83, α = .05. Second the perspectives scores of boys (*M* = 2.76, *SD* = .75) and girls (*M* = 2.58, *SD* = .83) were also not significantly different, *t* (39) = .72, *p* = .48, α = .05. Third, the differences between the voice scores of boys (*M* = 3.65, *SD* = .61) and girls (*M* = 3.25, *SD* = .68) were not statistically significant, *t* (39) = 1.93, *p* = .06, α = .05. However, in every criterion, the mean scores for boys were slightly higher than those for girls.

Table 6. Descriptive statistics of learning outcomes

	Gender	*N*	Mean	*SD*	*SE* Mean
Relevance	Male	17	2.65	1.06	.26
	Female	24	2.58	.83	.17
Perspective	Male	17	2.76	.75	.18
	Female	24	2.58	.83	.17
Voice	Male	17	3.65	.61	.15
	Female	24	3.25	.68	.14

Note. N = sample size; SD = standard deviation; SE = standard error.

Table 7. Gender differences in learning outcomes

					95% CI	
	t	*p*	Mean Diff.	*SE*	LL	UP
Relevance	.22	.83	.06	.29	-.53	.66
Perspective	.72	.48	.18	.25	-.33	.69
Voice	1.93	.06	.40	.21	-.02	.81

Note. CI = confidence interval; Diff = difference; LL = lower limit; SE; standard error; UP = upper limit.

3.3 Correlation between Game Play Time and Learning Outcomes

The correlation between time spent playing *Statecraft X* and relevance, perspective, and voice were all non-significant. The results indicate that there were no significant associations between the time boys and girls spent playing *Statecraft X* game and the learning outcomes of relevance, perspective, and voice (see Table 8). The Spearman correlation rank coefficients were -.073 (*p* = .64), -.094 (*p* = .57), and .19 (*p* = .24) for relevance, perspective, and voice respectively.

Table 8. Correlation between game play time and learning outcomes

	Game play time per week	
	Spearman rho	*p*
Relevance	-.073	.64
Perspective	-.094	.57
Voice	.19	.24

In other words, the learning outcomes of students did not have a statistically reliable relationship with game play time. A student could spend little time playing the *Statecraft X* game and yet achieve high scores in the written task. In Figures 4, 5, and 6, scatter plots show that students achieved high scores on relevance, perspective, and voice of 3 and 4 despite having reported spending little time in game play.

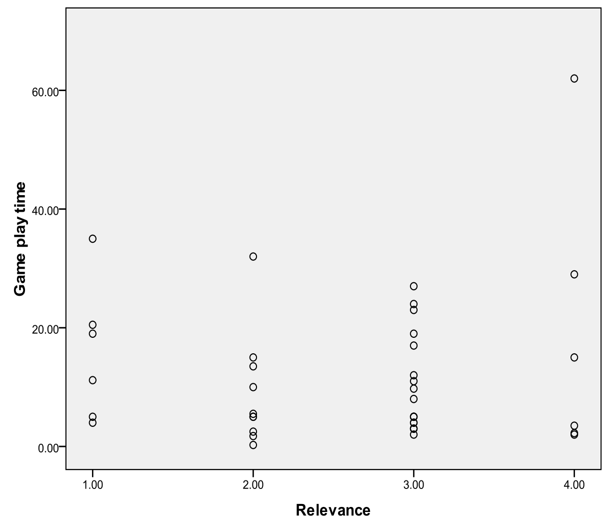

Figure 4: Distribution of relevance scores and game play time

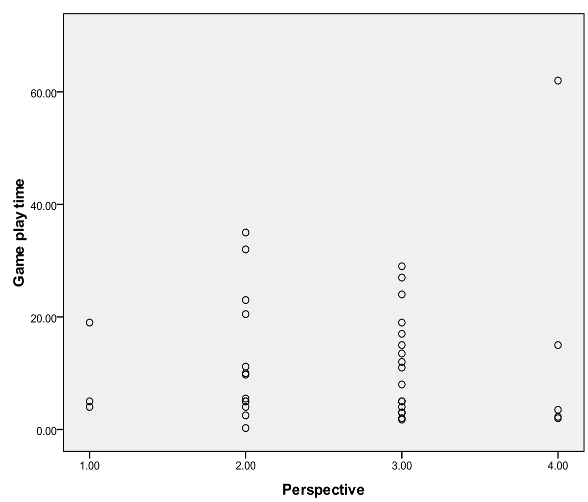

Figure 5: Distribution of perspective scores and game play time

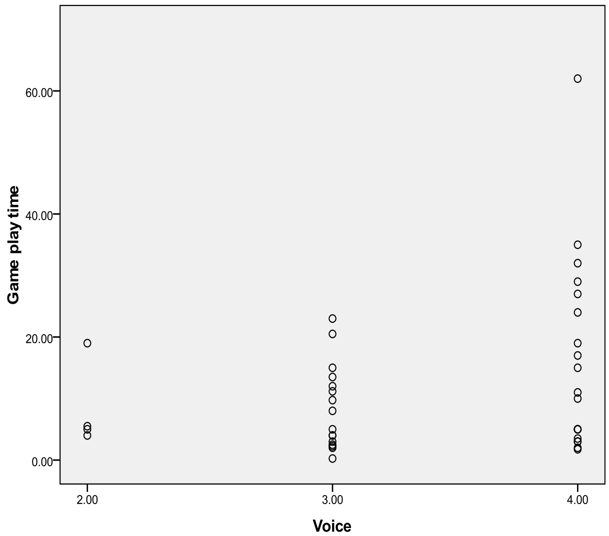

Figure 6: Distribution of voice scores and game play time

4. DISCUSSION

The objectives of the present study were (1) to investigate whether there were gender differences in game play time, (2) to investigate whether there were gender differences in learning outcomes, and (3) to investigate whether there was a significant correlation between game play time and learning outcomes in ninth-grade students who participated in the *Statecraft X* game-based curriculum. Previous studies have not compared gender differences in game play time if game content and access and control over game devices did not favor males. This study is also a first attempt to look at game play time and its effect on learning outcomes. Consistent with previous studies (Buchman & Funk 1996; Bertozzi & Lee 2007; Chou & Tsai 2007; Green & McNeese 2008; Solomonidou & Mitsaki 2009; Winn & Heeter 2009), we found that there were significant differences found in game play time between boys and girls. We will now discuss the factors that could have contributed to gender differences in game play time and the factors that could have contributed to no significant differences in learning outcomes and to no significant correlation between game play time and learning outcomes.

4.1 Game Content

One factor that might have contributed to gender differences in game play time was game content. It could be that the game content of *Statecraft X* did not sufficiently appeal to girls because they reported spending less time in game play than boys. In an earlier paper, we reported that the greatest difference in player actions between boys and girls was the category of military actions. Boys took about six times more military actions than girls. This could be due to the fact that in the first lesson, the *Statecraft X* game was positioned in such a way that the winning faction was the faction that captured the capital city. This might have led to the high number of military actions taken by boys in a bid to win the game. In a subsequent intervention, the first author, a female researcher, advocated a change in the positioning of the game. The winning faction would be positioned as the faction that had the highest composite score of happiness, profit, and population levels in the towns under their charge. With this shift, girls might engage in more game play. This change was instituted in a subsequent intervention but the investigation of this hypothesis is still pending.

Another reason could be that girls were more thoughtful in their game play. They might strategize more before engaging in game play after reading blogs and listening to class discussions. They also might think that the game was the point of departure for the curriculum rather than the major part of the curriculum and therefore prioritized their time accordingly.

4.2 Access to and Control over Game Space

Given that all students in this study were loaned each an Apple iPhone, there should be equal access to control over game space. However, the gender differences in game play time indicate that boys still played the *Statecraft X* game more frequently than girls. Perhaps, teenage girls wanted some control over their daily lives and did not want game play to intrude too much into their daily lives at home which revolved around homework.

4.3 Learning Outcomes

Consistent with Papasterigou (2009)'s findings, this study found that there were no significant gender differences in the learning outcomes of a game-based curriculum. The non-significant gender differences in learning outcomes could be due to the fact that the first author who is a female designed the lesson plans executed for the study and who designed learning activities that catered to both girls and boys. Having a curriculum model that goes beyond the game world into the fictional and real worlds might have allowed girls and boys who had little time for game play to still benefit from the *Statecraft X* curriculum. Although some students have less first-hand experience with game play, they might have gleaned insights from the blogs of their classmates and from class discussions and student presentations. Another possibility is that although the girls played the *Statecraft X* game less often than boys, they played enough to make meaning of the game play in terms of governance so that they were able to participate in the learning activities designed in the *Statecraft X* curriculum and to achieve desired learning outcomes. That is, even though a boy or a girl were not to spend a lot of time in game play, they could still achieve good learning outcomes.

4.4 Limitations of Present Study

The present study had certain limitations. This study involved a short-term intervention in a high school. It would be interesting to investigate whether there would be long-term learning outcomes in school tests and examinations, and students' interest in social studies as a result of a social studies game-based curriculum. Another area for future research is to develop a web-based version of the *Statecraft X* game and to investigate game play time and learning outcomes in such a curriculum compared to a mobile version of the game. That is, if girls or boys have to share a computer with other family members in their home to play the web-based version of *Statecraft X*, will there be any difference to their learning outcomes? This will further illuminate the importance of access to and control over game space in game-based learning.

The *Statecraft X* game was also initially designed by a male game designer. However, with the input from female members of the *Statecraft* team, the game content could be modified in such a way that both male and female preferences for game play are paid greater attention in future interventions.

5. CONCLUSION

The results of the study showed that the learning outcomes of a game-based learning curriculum were not solely dependent on the hours students spent on game play. The learning outcomes were also not significantly different between boys and girls although boys reported spending significantly more hours than girls in game play.

Educational games can contribute to learning in both male and female student populations. Future educational games can be produced with greater consideration of the preferences of girls in terms of game content. In this way, these games are less likely to suffer from gender bias and they can also tap on the purchasing power of females.

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Appendix 1: Scoring guide for scoring relevance, perspective, and voice in students' essays

Criteria	**Level 1**	**Level 2**	**Level 3**	**Level 4**
Relevance	Policies proposed are not relevant to the social and economic needs of the country. Most examples given are simplistic. Do not diverge from the textbook.	Examples given may include a non-textbook source or an innovative interpretation. Examples given may include a non-textbook source or an innovative interpretation.	Policies proposed meet the social and economic needs of the majority of the population. Examples given are appropriate and include non-traditional sources.	Policies proposed meet all the social and economic needs of this country. Examples given effectively support all the policies proposed. Examines examples given for its relevance.
Perspective	Offers only the textbook perspective.	Limited discussion of perspectives other than the textbook perspective. Alternatives are not integrated. Treats other viewpoints superficially.	Offers multiple perspectives, but they are integrated in a limited way. Attempts to investigate viewpoints.	Integrates diverse multiple relevant perspectives. Multiple viewpoints are thoroughly discussed, explained and qualified.
Voice	Is indifferent towards the topic. Does not communicate feelings. Does not offer any opinion. Writing is stilted or awkward, phony. The reader is clueless about the personality of the writer. Voice used is inappropriate for the situation.	Cares about the topic in a limited way. Communicates feelings as an afterthought. Opinions are emergent in nature. Major inconsistencies cast doubt on the authenticity of the piece. The reader has to examine the piece carefully for indication of the writer's personality. Voice used matches the situation at times.	Cares about the topic. Communicates feelings. Opinions are outlined. A few inconsistencies in the piece. The reader gets a glimpse of the writer's personality. Voice used largely matches the situation.	Cares deeply about the topic. Communicates strong feelings and honest statements. Only the writer could have written it. Opinions are well-defined and detailed. Writing is authentic. The writer's voice is consistent throughout the essay. The writing sounds real. Displays a well-developed personality. The reader has the impression that he is getting to know the writer very well. Voice used matches the situation very well.

Guidelines for the design of location-based audio for mobile learning

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Abstract

In this paper, we discuss the value of location-based and movement-sensitive audio for learning. We distinguish three types of audio learning experience: audio vignettes, movement-based guides and mobile narratives. An analysis of projects in these three areas has resulted in the formulation of guidelines for the design of audio experiences. We offer a case study of a novel audio experience, called 'A Chaotic Encounter', that delivers an adaptive story based on the pattern of movements of the user.

Keywords

Audio narratives; mobile learning; audio guides; location-based experiences.

1. INTRODUCTION

A consistent finding of research into mobile learning guides and outdoor learning games has been the value of audio as a medium of communication (see e.g. Bhaskar and Govindarajulu, 2010; Naismith *et al.*, 2005; Schwabe and Goth, 2005). This complements earlier findings from studies of distance learning which showed that students like being informed by the voice of their educator, listening to interviews or debates, hearing from experts and being encouraged with a reassuring audio message (Durbridge, 1984). The difficulty with audio as an instructional medium is that it can be hard to concentrate on a voice for long periods, it is difficult to retain de-contextualised audio information for later reflection (Laurillard, 2002) and some topics can be explained more effectively through pictures or graphics (McConnell and Sharples, 1983; Minocha and Booth, 2008).

This indicates two, diverging, opportunities to exploit audio as a medium for mobile learning: in podcasts, where the audio is de-contextualised and may need to be supplemented by graphics, images or video to explain or illustrate a topic; and in location-based guides, where the physical surroundings complement the audio commentary.

This paper has a focus on audio experiences, including guides, games and stories, that are either matched to location by position-sensing technology such as GPS, or that respond to the physical movement of the user.

The initial challenges for designers of location-based mobile learning are to:

- ensure that the learner is at the right place and looking in the right direction, so that the sound and the view are matched,
- minimise the need for learners interacting with the device so that that they have a 'heads up' continual flow of visual information rather than frequently shifting gaze between the scenery and the screen.

Physical movement around the environment can provide an effective method of interaction (Bristow *et al.*, 2002). Contextualised information can be adapted to the user's preferences and profile, their route, their current position and orientation, whether they are standing or sitting, and how long they have been at the current position. Thus a person's movement and posture can provide means of interacting with a combination of the physical surroundings and audio educational material, without the need to gaze at a screen or press buttons.

This paper provides an overview of the use of audio for location-based encounters. It provides a classification of types of verbal audio and examples of their implementation in mobile learning systems, followed by guidelines for the effective use of audio, drawn from the examples. We then present a case study called 'A Chaotic Encounter', an example of a novel approach that combines movement-based guides with mobile narratives (an adaptive narrative). We report an initial evaluation with ten users along with suggestions for future work.

2. TYPES OF AUDIO EXPERIENCE

Audio has been used effectively in many location-based experiences, including mobile gaming (Drewes *et al.*, 2000; Lyons *et al.*, 2000); tourism (Aoki *et al.*, 2002; Naismith *et al.*, 2005); educational visits (O'Hara *et al.*, 2007; Vavoula *et al.*, 2009) and theatrical events (e.g. Hotter than Hell[1]), or a combination of these activities (Rowland *et al.*, 2009; Schnädelbach *et al.*, 2008).

Audio can be used for directional purposes, for example to tell the user to follow a path until a particular landmark is reached, or to orientate them so they are facing a specific feature of the landscape or museum exhibit. It can be designed to engage the user in a task-based activity, particularly in educational scenarios, where the student is asked to make notes or take measurements/observations relating to their immediate environment. It can also be used to provide information about an object or scene, as a story-telling device, or to create ambient sounds relevant to the environment such as birdsong or machinery. These instil a more authentic atmosphere and make the experience more realistic, as demonstrated in Ambient Wood (Rogers *et al.*, 2004).

In this paper, we concentrate on the use of spoken audio rather than non-verbal audio. We propose three broad classes of movement-based audio experiences:

- *Audio vignettes*, where the user's movement into a location triggers audio, but there is no adaptivity based on previous movement;
- *Movement-based guides*, where the aim is to adapt information to objects or surroundings, and the interaction and adaptivity is based on user movement;
- *Mobile narratives*, where an audio narrative is performed based on a sequence of user movements.

These three forms of audio guide have some common properties and requirements (e.g. audio as the main means of delivery), some differences (e.g. whether the audio should be independent of previous location, adaptive to it, or cumulative), and some dependencies on the particular design goal (e.g. whether, and how, the users should be explicitly informed of the relation between their movement and the audio).

3. AUDIO VIGNETTES

We classify audio vignettes as short pieces of audio triggered by movement from the user. However, there is no history of where the user has been, and hence no adaptivity based on previous movement. Thus, users are able to engage with chunks of audio that are independent of each other and of their relative locations. Depending on the design, it could be possible to interact with some, all, or none of the audio segments in a particular place or sub-area, with either the computer or the user choosing which aspects of the place to engage with. Missing out some vignettes should not necessarily disadvantage the user since the information in each should be self-contained, although there might be added value if related vignettes are played within a short space of time (e.g. audio descriptions of information relating to archaeological exhibits found at the same geographical location or with a common theme).

Examples include work by Bederson (1995), who created non-linear browsing for museum exhibits: a piece of audio would be attached to each artwork and this would be activated based on the proximity of the user. Since this was a non-linear system, users could approach any exhibit in any order; they could re-visit them or choose to skip over any that they were not interested in.

Rozier *et al.* attempted to take this further, by allowing users to overlay their own audio recordings onto existing 'audio imprints' that were already present in their immediate environment (Rozier *et al.*, 2000).

The 'Riot! 1831' project (Reid *et al.*, 2005) provides an excellent example of audio vignettes. This was an interactive play created using mScape[2], based around the riots which engulfed the Queens Square area of Bristol in 1831. Participants were given PDAs running the mScape client; they were then free to explore Queens Square on their own. GPS positioning on the device monitored the user's position and the area was divided into regions. When the GPS reported that the user had entered one of these regions, it triggered a short audio vignette depicting events of the riot which occurred in that place. These were not sequenced in any way, so users could freely wander between regions (and vignettes) in any way they chose.

Evaluations of 'Riot! 1831' report a positive experience for most users, however some feedback indicated that there seemed to be no overarching narrative and it could be difficult at times to get a more holistic overview (Reid *et al.*, 2005). The authors also encountered problems with the GPS signal often being adversely affected by buildings or weather conditions. When this occurred, they intervened to stop participants from using the system and encouraged them to return later.

Issues relating to the effectiveness of audio vignettes in outdoor locations have been explored through the 'Augmenting the Visitor Experience' project (Priestnall *et al.*, 2009). Here, groups of students were asked to develop their own mediascape for an area of the English Lake District, which would act as a free roaming visitor guide to some of the hidden cultural and geographical aspects of the landscape around them.

Pre-recorded audio vignettes describing vistas from specific locations were made available, along with audio descriptions of points of interest and miscellany relating to

[1] http://www.aerial.fm/docs/projects.php?id=101:0:0:0

[2] http://www.mscapers.com/

areas with more indeterminate boundaries. An important aspect of the most recent occurrence of the field project was to encourage students to record their own audio using mp3 voice recorders. The effectiveness of audio was then tested in the field, using video diaries created by the students as one mechanism for gathering evidence.

Findings revealed difficulties experienced by the users in associating standalone audio vignettes with the corresponding landscape features. As with 'Riot! 1831' there were issues with GPS reliability, but also more subtle influences on the user experience, resulting from audio not being delivered at the locations intended.

Nevertheless this is an important category of audio guide and one that has proved popular at many tourist attractions and museums. Its popularity is due in part to the relative ease of authoring and delivering the vignettes, where each audio segment can be offered on its own, with no need to predict or respond to the route taken by the visitor. It also allows freedom of movement by the user, with no compulsion to follow a prescribed path.

4. MOVEMENT-BASED GUIDES

In a movement-based guide, the user's movement within and between locations, as well as changes to physical posture, orientation and gaze can all provide means of interaction and opportunities for adapting the content and delivery of educational material. In a museum or gallery, the layout of rooms and exhibits is designed as a structured information space, so any physical movement around the rooms is also a traversal between concepts. This can be used to advantage in a mobile guide. Consider a person standing in front of a painting in a gallery. A context-aware guide could adapt its content and presentation to take account of the person's route to that location ("you seem to be interested in pre-Raphaelite paintings"), their current location ("the portrait here is also by Rossetti"), their orientation and gaze ("if you turn further to your right you can see a similar painting by Burne-Jones"), and the time they have been at the current location ("now look more closely at the folds of the dress").

An outdoor setting may not be designed deliberately for an educational purpose, but it will have structure, coherence and continuity that can be exploited by a movement-based guide. For example, a rural landscape can reveal contrasts in agricultural use, or changing rock formations along a pathway.

The CAGE system was a prototype movement-based guide designed for a city art gallery (Rudman *et al.*, 2008). The location of the user was determined by an ultrasonic positioning system that was accurate to about 10cm. The user received audio through headphones, that continually adapted to: the nearest painting (as determined by the ultrasound positioning system); the length of time at a painting (the system assumed that the longer a person stayed at one place, the more they were interested in that painting); and the previous time at the position (the content was only repeated on request).

CAGE was evaluated through a comparison with a traditional printed guide. In general, the location-based delivery of content worked well and people liked using the technology. The adaptivity matched users' expectations, and feedback indicated that they found the presentations appropriate and useful. The evaluation found no significant differences between the handheld guide and printed sheet as sources of information, which is not surprising since they contained similar content. A particular success was one painting where the users were given increasing level of information the longer they stayed, encouraging them to look more closely into details of the imagery. This also worked with groups, who shared the headphones. One group of participants spent over three minutes pointing out details to each other and discussing what they were hearing. Other pairs of visitors talked about what they were seeing, prompted by the information from the guide.

Although the CAGE evaluation indicates success in customising the delivery of content based on the route, position and time at the current location, it was less successful in enabling users to make links between exhibits in different locations or in encouraging them to break their linear movement around the perimeter of the gallery. Further research is needed into how people's physical movement can be used as the basis for a coherent sequence of instruction or guidance.

A difficulty of movement-based guides lies in authoring the content so that it adapts to the user's activity. This is a well-recognised problem for intelligent tutoring systems and partial solutions range from the labour-intensive task of creating different content for typical routes, to implementing a computational model of the learner's interest and activity linked to automated generation of audio content (Gustafsson *et al.*, 2006) Adaptive tutoring systems based on computational models of learner activity and inferences as to the learner's cognitive state is an active area of research, with recent work exploring how such models can be presented to the learner to promote reflection (see e.g. Bull and McEvoy, 2003).

5. MOBILE NARRATIVES

In a mobile narrative, an audio narrative is performed that is based on the sequence of movements carried out by the user. Hence, the audio heard by a user will depend upon where the user goes to (and has come from). For example, you would expect a mobile narrative to integrate aspects of location that the user has already visited, but not those that they have not.

It differs from a movement-based guide in having a strong story-telling component and a level of dependency upon the previous audio segment. It may present different perspectives, so that an event or a place is told by different characters, presenting multiple interpretations that can prove fascinating to a user (Lim and Aylett, 2007; Tozzi, 2000). These different perspectives can also provide a deeper learning experience than having a single narrative, since users can critically analyse the viewpoints and make their own conclusions, compared to having a single stream of information provided to them. It could also be more engaging than individual audio vignettes, since different aspects of the mobile narratives form part of a larger story, thus creating a broader background upon which these narratives are set (Roden *et al.*, 2007).

An example of how this has been created is the 'Mobile Narrative' framework, developed to facilitate the delivery of context-sensitive stories on the iPhone platform (Wiesner *et al.*, 2009). The framework allows an author to create a textual story, divided into multiple chapters. Certain chapters can then be restricted so that the end user can only read that chapter at a specific time or location, as monitored by the phone's internal clock and GPS receiver. Those reading the stories were often irritated by this imposed inaccessibility, regarding it as arbitrary and resenting their loss of control while writers were concerned that these limitations reduced accessibility. This project has only so far been developed in textual format and not in spoken audio, however it highlights the potential pitfalls of forcing users to access content only at specific times or that meet certain criteria, thus reducing and limiting their interactivity with the narrative.

In contrast, "History Unwired" was a freely-usable mobile narrative (in terms of cost to the user and lack of time restrictions) created as a walking tour around part of the lesser-visited yet culturally-rich areas of Venice. It was delivered over location-aware PDAs and mobile phones, to over 200 users, as an alternative to the mass tourism offerings provided elsewhere (Epstein and Vergani, 2006). It followed the personal stories of five local Venetians, who had been interviewed to provide folkloric commentaries on the area in which they lived. Location sensing was provided via Bluetooth due to intermittent GPS coverage in the streets of Venice. Initial user evaluations suggest that the authenticity of the storytellers was very well-received, with some users even meeting one or two of the characters in person. The narrative also provided opportunities to "open up" parts of the city whilst also respecting the privacy of the residents ("closed" areas). Further work is now being carried out by the project developers to investigate the possibility of developing mobile media for sustainable tourism, in co-operation with the local tourism offices.

6. GUIDELINES FOR EFFECTIVE AUDIO EXPERIENCES

Based on the above examples and the design experience of the authors, the following design guidelines are proposed for the creation of effective audio experiences. These are offered as initial suggestions to the mobile learning community and further work is needed to test and refine the guidelines. The guidelines are categorised under several headings: interactivity; narration; trails/navigation; technical issues; and sensitivity to the local environment.

Interactivity:

- An audio experience should be interactive: in the examples given above, the ability of the user to interact with and potentially influence the story (or at least have some control over it) appears to add significant value to the experience.
- This interaction should be dependent on the user's movements. A history or trail of where the user has been can enable the delivery of an enhanced experience and can avoid repetition.
- Under some circumstances, the precise dynamic by which movement affects the narrative should be obscured from the user. This allows the narrative to provide 'ambient informatics' (Greenfield, 2006) regarding the user's movements – the experience is enhanced by allowing the user to gain this information subtly. This is exemplified by 'I Seek The Nerves Under Your Skin', an adaptive poem in which the user had to constantly accelerate in order to continue hearing the poem. The ongoing narrative provided subtle information about the speed of the runner (Marshall, 2009). Gaver *et al.* (2003) also note that such ambiguity allows the designer to raise questions about a user's behaviour without having to necessarily answer them and can additionally compensate for the inaccuracies of sensors.

Narration:

- It is preferable for the narrative at all times to remain coherent and flowing, so that the user does not get 'lost' in the different audio offerings.
- Reducing the reliance on visual material can make an audio experience more engaging and promote curiosity in the user (Sprake, 2006). To that end, the delivery should employ audio alone whenever it can tell a compelling story or complement the visual surroundings. There is an established precedent for this in the examples of audiobooks and audio guides, which allow people to listen without impeding their routine patterns of movement. The content should therefore be able to respond to these patterns without necessarily affecting them. However, users can also be encouraged to experiment with new and unusual styles of movement in order to gain a different narrative experience, as shown by Marshall (2009).

Trails/navigation

- It cannot be assumed that users will follow the path proposed by the guide. The trials of the CAGE system indicated that it is difficult to persuade people to deviate from a typical route, so it may be better to adapt rather than persuade.

Technical issues

- The audio should adapt to the failings of sensor technology in order to avoid having to abandon the experience when sensors stop functioning, as was the case for 'Riot! 1831' but was overcome by using Bluetooth in 'History Unwired'.
- Where the precise location of the audio in relation to features in the landscape is important, then the shape and extent of the 'trigger' regions should be designed to allow for fluctuations in calculated position caused by inaccuracies and 'wander' in the GPS data.

Sensitivity to the local environment

- Even when GPS positioning can be assumed to be accurate, there remains the issue of the 'geographic relevance' of audio, particularly when it is important that the user associates that audio with specific features in the landscape. Evidence from field exercises (Priestnall *et al.*, 2009) is that users commonly fail to associate the audio description with the landscape, by looking in the wrong direction. This suggests that designers should understand the geographical reference points and landmarks that may be important in a particular environment.
- Sensitivity to local surroundings is especially important when the audio experience takes place in an outdoor location. In History Unwired, sensitivity to local humour, privacy, art and culture was instilled from an early stage in the design of the experience. At the same time, there was a delicate balance to be maintained, so that the tour was not sensationalistic or voyeuristic (Epstein and Vergani, 2006).

7. CASE STUDY: A CHAOTIC ENCOUNTER

In this section, we present an example of a relatively unexplored category, that combines movement-based guides with mobile narratives (an adaptive narrative). Users of *A Chaotic Encounter* are provided with a small PocketPC featuring a GPS sensor, touchscreen and a headphone jack. This system, created using mScape (Stenton *et al.*, 2007), delivers an entertaining audio story, based on Nottingham folktales, which adapts its content to reflect the listener's movement patterns. Its concept was inspired by the Situationist movement, which proposes that peoples' everyday movements can be considered as objects for artistic study (McDonough, 1994). Ordinarily, a person might listen to a regular audiobook or podcast to distract them from the experience of a regular journey (such as the walk to work). This system is intended to be used in the same situation but to opposite effect: it focuses the user's attention on the routine of movement, encouraging them to reflect on how interesting these movements are (and how interesting they could potentially become). Its design was informed by the guidelines described above, with particular reference to narrative structure and movement-based interaction. Specifically, it aimed to investigate whether users preferred to explicitly steer the story's development manually, or have the plot automatically adapt itself according to their movements.

The narrative is structured around the tree-branch model outlined in Phelps (1998), as this provides the linearity necessary for an enjoyable story (Paay *et al.*, 2008). The story is divided into three levels, each of which corresponds to the classic story structure of Exposition-Climax-Denouement defined by Freytag (1895).

At each level, there are one or more 'acts': short audio segments which perform the function of that level – for example, all of the acts at the Climax level depict the characters encountering a problem that must be solved, while those at the Denouement level present the solution of that problem and the story's conclusion. Each act can branch to one of three acts on the next level: these three all fulfil the same story-advancing function necessary for their level but differ in their content. Each has a 'Chaos Rating' representing the predictability of their content: a Low Chaos act features few characters and is relatively mundane, while a High Chaos act has many characters and is more surreal. A Medium Chaos act sits between these two extremes of the bland and fantastic. Thus, as the listener progresses from one level to the next, they have a range of Chaos Levels to choose from but will always experience a traditionally linear story.

The mechanism which determines this choice is hidden from the user. The system constantly records the user's speed and direction of movement during each act and then, at the end of the act, draws on this record to determine the appropriate Chaos Level to progress to. This calculation is based on the number and extent of the recorded changes: if these values are low (that is, if the user maintains a constant speed and direction) then a Low Chaos act is selected whereas if they are high (if the user often changes speed and direction, moving erratically) then a High Chaos act is delivered instead. Once this decision has been made and enacted, the movement records are erased so that the process can begin anew during the next act. The whole decision-making process takes place quickly enough so as to appear seamless to the user: one act instantly segues into the next so that the listener is left with the impression that they are hearing one continuous audio narrative when, in fact, it is composed of several segments corresponding to specific branches in the narrative tree (see Figure 1). It is only with multiple uses that they might come to realise that it is interactive at all, or that their movements have an effect.

The system is designed such that, after initial activation, the screen is unused and the device can be left in a pocket throughout playback. However, should GPS reception become unavailable for a prolonged time while the story is playing, the system provides brief audio and visual messages warning them that this has occurred and to move away from potential sources of interference. The user can also avoid GPS altogether: when the system is activated, it allows them to choose between 'automatic' and 'manual' settings. Automatic mode uses the GPS system described above, while manual mode does not rely on sensors at all: rather than measuring the listener's movements, at the end of each act it pauses playback and presents, via the touchscreen, an interface for manually choosing the Chaos Level of the next act, which begins playing once the choice is made. This method sacrifices ambient reflection, but provides much greater reliability.

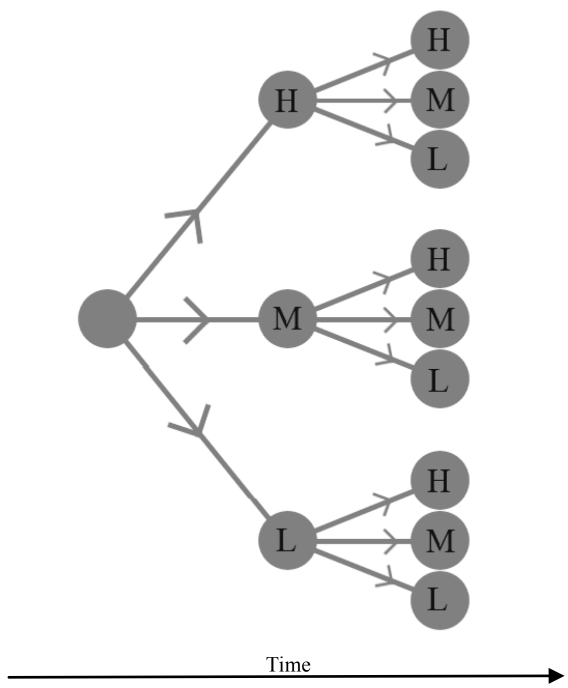

Figure 1: Narrative structure in *A Chaotic Encounter*

User trials were conducted with a group of ten participants, three of whom agreed to be interviewed and complete a questionnaire about their experience. Users were selected on the criterion that they regularly listen to a portable audio device while making routine journeys. They each tested the system individually, and were initially informed that the system relied on GPS technology to measure movement but were not told how or why this was this case. Instead, they were briefed to initially listen to the story in automatic mode at least twice, while walking through the city. Following this, they were encouraged to try manual mode. Finally, they were debriefed and given the questionnaire assessing the extent to which they felt their movements had an effect on the narrative, whether they became more conscious of their movements, how much they engaged with the story and their opinions on the two modes of operation. User responses to the design were mixed: all agreed that they had enjoyed hearing the story, demonstrating the value of adhering to classic dramatic story structure. However, on their second listen, some reported feeling confused and unable to understand what they were meant to be doing differently, while others responded positively and quickly began experimenting with different movement styles. One user reported that although they enjoyed exploring the relationship between movement and story, they ultimately chose to use manual mode to provide precise control and prevent repetition. This suggests that ambiguity can be a potential resource in effective design, but can risk alienating users and must be carefully managed.

Nevertheless, the participants generally agreed that the manual mode, driven by explicit choice, was less enjoyable as it regularly interrupted the story to demand that they interact with the screen. This demonstrates Ryan's claim that explicit interactivity threatens immersion by forcing the user to step out of the fictional world (Ryan, 2001). However, in some cases the intermittent availability of GPS caused incorrect recording of movement, leaving the user being presented with the same story multiple times. This demonstrates the need to find an alternative to GPS that provides more reliable movement sensing, as well as a method that does not rely on movement sensing but also does not require constant user input. The former could be solved by the use of accelerometers, which are more reliable and sensitive than GPS (Slyper and Hodgins, 2008). The latter could use a randomiser to determine story progression when movement data is unavailable – this would strip the experience of its ambient reflectivity, but would not break immersion. This method could also store details of the previous story path taken and avoid it in future, to prevent accidental repetition.

8. CONCLUSIONS AND FUTURE WORK

We have presented an overview of how verbal audio can be used effectively by users as they physically move around their environment. We described 3 categories of how this can be achieved: through *audio vignettes*; *movement-based guides*; and *mobile narratives*. From case studies from these categories, we distilled some guidelines for the design of audio for engaging location-based experiences. These guidelines have yet to be tested fully but they are offered here as a starting point for future work and for discussion by the mobile learning community.

We have also presented *A Chaotic Encounter*, an example of an adaptive narrative, that provided users with differing narratives depending on their movements (described here as the amount of user 'chaos' that the system reacts to). Preliminary user trials, although not extensive, have indicated a mixed reaction by users. However it has highlighted an important aspect of the work, namely the immersive experience of the story based upon the location of the user. Despite the limitations of using GPS technology to track movement patterns, users of *A Chaotic Encounter* reported that it was a mostly entertaining experience. All users found the concept of movement-based narratives novel and enjoyable, and agreed that a branching narrative structure was exciting and inspired curiosity. This demonstrates that it is possible to introduce interactivity to a narrative without rendering it incoherent, that such interactivity is seen as highly valuable when it provides subtle information on user behaviours, and that audio is a very good medium through which to deliver such narratives as it requires minimum interruption.

Future work will explore how audio guides can be used to augment a sense of place through a combination of guidance and narrative storytelling and also building on previous work carried out by Walker into cinematic narratives (Walker, 2004). Further research is needed into the cognitive and social aspects of audio guiding, including how words and phrases are interpreted in relation to location, how people gain a 'sense of place' from spoken commentary, and ways to engage groups of visitors in a shared narrative. By drawing on literary-linguistic theories, we aim to investigate how the story content of an audio narrative can be structured and composed in order to achieve its desired effect – be this entertainment or education.

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Using mobile phones in implementing science lessons: teachers' pedagogical practices

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Abstract

How mobile phones support teachers' pedagogical practices when implementing lessons is discussed in the light of the findings from four science lessons conducted in Sri Lanka. A qualitative approach was used in which the data were collected as video, audio, written material and field notes. The data were analysed using thematic network analysis with the support NVivo8 software. The results show that the mobile phone supported teacher's pedagogical practices related to attracting the student towards the lesson, implementing lessons in a student centred approach, developing students' knowledge, skills and attitudes, enhancing students' participation, enhancing the interaction between teacher and students and among students, and evaluating students' learning and behaviour.

1 INTRODUCTION

The use of mobile devices for learning**,** often referred to as mobile learning has been integrated into formal education and informal learning (Kukulska-Hulme 2009) during the last few years. Mobile devices offer flexible learning opportunities for teachers and students in different kinds of instructional settings (Corbeil & Valdes-Corbeil 2007) (Varshney & Vetter 2000). However, these benefits demand that we reconsider pedagogies in respect of these new approaches instruction. According to Conole et al. (2008) existing pedagogies may no longer be sufficient when learning is delivered by mobile devices. Traxler (2009) considers that mobile learning is immature in terms of its pedagogies and is developing rapidly. Thus a more precise understanding of pedagogical requirements is needed for mobile learning (Goh & Kinshuk 2006).

A dictionary definition of pedagogy is 'the science of teaching' (Oxford English Dictionary). The definition of the term 'pedagogy' varies with different educational philosophies and values, and by the different assumptions that are held about learning, child development, appropriate styles of instruction and curricula (Siraj-Blatchford et al. 2002). Alexander (2004) says definitions for pedagogy range from the societal broad to the procedurally narrow, and as an example he pointed out that in England pedagogy is commonly used in a more restricted sense, to be equated with practice of learning. Furthermore, Alexander identified teaching methods and student organization as two facets of pedagogy included in his conceptual framework of education practice (Alexander 1992) where pedagogy is one of seven interrelated aspects of educational practice.

Mileva et al. (2008) consider that emergent technologies for learning demand that educators revisit these existing pedagogies. Technologies seem to offer the potential for pedagogical innovation or act as a 'catalyst' for pedagogical change'. The development of new skills and approaches will be required to ensure the pedagogical effectiveness of mobile learning (Mileva et al. 2008). Furthermore they believe the pedagogical aspects of mobile learning are connected to processes such as identifying learner needs, choosing appropriate technologies, and designing motivating experiences that efficiently meet learning objectives. In order to develop innovative technology-supported pedagogy, the teacher's interpretation of the technology's value for instruction and learning in the classroom is important (Hughes 2005). Laurillard (2007) pointed out that it is possible to develop pedagogical forms for mobile technologies that draw out the cognitive activities learners need to carry out in order to achieve the intended learning outcome. Taylor et al. (2006) consider most theories of pedagogy fail to capture the uniqueness of mobile learning as these theories of teaching assume that learning occurs in a classroom environment. However Vavoula et al. (2004) report a set of pedagogical guidelines for learners, teachers, and, policy makers who are considering mobile technologies for teaching and learning. Their guidelines are intended to be a theoretically backed list of 'dos' and 'don'ts', validated by the audience. These guidelines include cost, usability, choice of technology, roles, equipment management, and support for the teacher, administration, collaboration, and security and privacy.

Recently, Herrington et al. (2009) reported a project which aimed to develop innovative pedagogies for using mobile technologies within an authentic learning environment to enhance teaching and learning in higher education. They investigated this using smart phones and digital audio players with 10 teachers from the Faculty of Education at the University of Wollongong. Each teacher explored and invented pedagogies that made appropriate use of a mobile device for different subject areas. Teachers planned and designed learning environments where mobile technologies could be used in their different subject areas and specializations. From these studies a large number of opportunities for the use of mobile phones under different authentic learning environments were identified.

This paper reports how mobile phones can support teacher's pedagogical practices during the implementation of science lessons. From this study it was found that mobile phones supported teachers' pedagogical actions related to conducting lessons, developing students' knowledge, skills and attitudes, enhancing students' participation and interactions and evaluating students' learning and behaviour. However, introduction of the new technology and the limited availability of mobile phones demanded that the teacher to adopt new pedagogical practices when managing the classroom.

2 BACKGROUND OF THE STUDY

This paper is based on a qualitative analysis of data collected during four science lessons where pupils and each of their teachers were provided with mobile phones which were conducted in Sri Lanka. Eight mobile phones were provided except in one lesson (house hold chemicals) where students used their own mobile phones. Before implementing the lessons a professional development workshop was held to plan, in groups of secondary level science teachers, each of the lessons. The following section outlines each lesson.

2.1 Lesson 1: Household chemicals

This lesson was designed for a lesson of 80 minutes duration for Grade 11 students. Three days before the lesson the teacher informed the students about the lesson, and asked them to collect images (using mobile phone camera) and information (including downloaded information from the internet) on household chemicals and to bring them to the classroom as saved materials. The lesson structure is given below.

1. Engagement[1]: The teacher named (randomly selected) students and asked them to transmit the pictures they brought (as saved images in their mobile phones) to the teacher's computer using Bluetooth. Then the teacher ran a group discussion about these pictures and classified them as detergent, food additives, cosmetics, and medicines.
2. Development: Using the now classified pictures, the teacher created a Photostory with the participation of the students. Then the teacher grouped the students into four groups, assigned one category of household chemicals to each group and asked them to create a poster with the support of leaflets from supermarkets containing pictures of the household chemicals. While students were engaging in the group activity the teacher combined the Photostory that they developed with a sound file (teacher had created this based on the important points that were mentioned in the curriculum), converted it to the mobile phone format and transmitted to each group leaders' mobile phone. Group leaders shared the file with other members of their group using Bluetooth. Finally students were asked to present their posters and the teacher elaborated on some important points.
3. Evaluation: The teacher evaluated the students by assessing the associated homework which was based on the Photostory transmitted to the students' mobile phones.

2.2 Lesson 2: Functions and reactions of simple voltaic cell

This lesson was created following 5E[2] structure for a lesson of 80 minutes duration for Grade 10 students. The following section provides a brief account of how the teacher conducted the lesson.

1. Engagement: During the engagement the teacher divided the students into 5 groups and provided two mobile phones, a piece of fruit, wires, and galvanometer and metal plates for each group. Then the teacher sent a video clip to students' mobile phones and asked them to construct a simple voltaic cell using the given fruit by following the instructions given in the video clip. Students set up the practical using natural fruits and apparatus, and recorded their observations using mobile phone video.
2. Exploration: In groups, the students developed a simple voltaic cell using laboratory apparatus, metal plates (each groups used different metals) and chemicals according to the instructions given in a worksheet. Again they videoed their observations and then shared them with other groups using Bluetooth Elaboration: Students presented their observations with the support of a poster as instructed by the teacher.
3. Explanation: The teacher explained the theory behind the students' observations in whole group discussion. The teacher instructed the students to re-observe video clips whenever required.
4. Evaluation: The teacher sent a few questions based on the class's observations to the students' mobile phones as SMS. Upon receiving the students' answers she sent feedback to each group via SMS.

2.3 Lesson 3: Investigating the mutual relationships between organisms and the environment - Analysing the environment biologically

This is also for a lesson of 80 minutes duration for Grade 11 students and the following steps were followed:

[1] The initial stage of a lesson is named as 'lesson engagement' in Sri Lanka

[2] In 5E model, the steps Engagement, Exploration, Explanation, Elaboration and Evaluation are used when implementing a lesson.

1. Engagement: The teacher introduced the lesson using a Photostory (linking students' prior knowledge and introducing new concepts) which described the organisation levels of an ecosystem.
2. Lesson development: Students were grouped, different roles (group leader, assistant leader, photographer, assistant photographer, writer and assistant writer) were assigned to each member of the group and they were assigned to explore four places in the school garden (2 mobile phones for each group and worksheets were provided). Then the teacher gave a briefing on the activity, and reminded them of the responsibilities and the role of each player and asked that the worksheet be completed during the allocated time period. Further, they were asked to capture five pictures to support their activity using the mobile phone. As groups, the students visited the four assigned places and engaged in taking images and completing the worksheet as well as observing the pictures they had captured. After the allocated time students came back to the classroom and each group sent 5 images taken from their assigned locations to the teacher's computer using Bluetooth. Then each group presented their findings based on the worksheet and the pictures that they sent to teacher's computer. After each presentation teacher gave a briefing on the main points.
3. Evaluation: The teacher assessed the students as a group based on their completed worksheets, captured images and presentations.

2.4 Lesson 4: The diversity of leaves

This lesson was conduced for Grade 6 students and the duration of the lesson was 80 minutes. The teacher used the following steps:

1. Engagement: The teacher introduced the lesson as a whole group discussion with the help of a PowerPoint presentation on the diversity of leaves.
2. Lesson development: The students were grouped and each group was given two mobile phones and a worksheet (each group was asked to collect images of different leaf colours, shapes, edges, and pinnate or non pinnate). They then went to the school garden to collect the images of the leaves. On returning to the classroom the students shared their images amongst the groups using Bluetooth. Then the teacher introduced a dichotomous key to classify the plant leaves. Based on the images they had in their mobile phones, each group constructed their own dichotomous key and presented it to the class. After each presentation, the teacher pointed out the important facts to note.
3. Evaluation: The teacher evaluated student groups based on their presentation and examining the images saved on the mobile phones.

Three of the above four lessons were implemented in mixed schools and the other one (environmental relations) was implemented in a girls' school. After the lesson implementations, there was a Review Workshop where the teachers came together to reflect on their lessons, and the use of technology.

3 DATA COLLECTION AND ANALYSIS

3.1 Data collection:

All the lessons were video recorded. Students' group discussions (both inside and outside the classroom) were also recorded using audio recorders. Also following each lesson four to five students (selected at opportunity) were interviewed. However, in one lesson students' views were collected as written comments as it occurred at the end of the last period of the school day. The researcher also recorded her own field notes. During the Review Workshop the teachers' discussions were captured using video, audio and as written materials.

3.2 Data analysis:

The above data were analysed using Thematic Network Analysis (Attride-Stirling 2001) with the support of NVivo8 qualitative data analysis software. All the paper based materials were first transcribed, saved as word files, and uploaded into NVivo8 software. Then video and audio files were uploaded into the NVivo8, and then transcribed and translated where necessary. A set of codes were derived to represent themes in the data through careful review of the written materials (students' comments, teachers' reviews, and field notes), the video data files and the audio data files. Based on these codes 'tree nodes' were developed in NVivo8 software and using these 'tree nodes', the uploaded written materials and transcribed data were split into meaningful segments (see Figure 1).

All the text segments in each free node were read again to identify the salient and common themes in them to create tree nodes for each of the themes. The tree nodes created in this way were then refined so as to be specific enough to be discrete (non repetitive) and broad enough to encapsulate the set of ideas contained in the associated text segments. After that these refined themes were assembled into similar, coherent groupings-basic themes. Basic themes were then clustered by shared issues to make organising themes. In the light of these clusters, the global themes were derived. Afterwards, the basic themes (squares), organising themes (circles) and global themes (octagons) were illustrated as non-hierarchical, web-like representations.

4 RESULTS AND DISCUSSION

The thematic network of 'the use of mobile phones in lesson implementation' as shown in Figure 2 concisely illustrates the key themes on which lesson implementation was based on, i.e. each teacher's actions and behaviour, supported students' behaviour and introduced technological challenges.

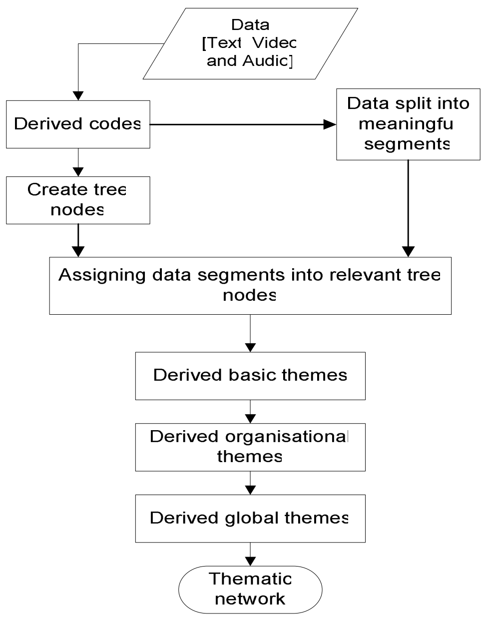

Figure 1 Thematic analysis

4.1 Organising theme: Supported to teachers' behaviour

This organising theme describes the support that mobile phone functions provided for different teaching acts of the teacher ranging from organising and managing the classroom to explaining subject matter, assigning activities, interacting with students and assessing students' work.

4.1.1 To teachers' managerial processes:

The teachers' acts during the lesson implementation revealed the importance of their role as managers, to put their lesson plans into practice, to achieve the expected outcomes of the lessons while integrating novel technology in their science teaching. It was observed that the support of mobile phone to the teacher in terms of his/her managerial role varied. One example is getting students' attention towards the lesson. At the outset of all four lessons, it was observed that the teachers managed to do this. Three teachers out of four used the mobile phones to direct students' attention towards the strategic aims of the lesson as shown in Table 1.

Table 1: Uses of mobile phones to introduce lesson aims to

Lesson	Strategy
1	Teacher named a student to send his/her images (captured from home) to the teacher's laptop computer.
2	Teacher sent an instructional video clip via Bluetooth to each group's mobile phone and asked students to construct a simple voltaic cell.
3	Teacher used a Photostory, constructed using some images captured with his mobile phone, to remind the students of concepts they had learnt in the previous classes and to introduce new concepts.

Teacher's instructions relating to the use of a new technology were highlighted during the lesson implementation. All four teachers provided the necessary instructions to avoid students' misuse of mobile phones. Further, it was also noted that there were additional managerial functions imposed on the teacher due to the students' use of mobile phones. For instance

1. Prior to the lesson teachers gave necessary technical instructions to students through hands-on sessions.
2. Just before each activity teachers reminded the students of the instructions that they were already given.
3. Teachers also gave instructions necessary to overcome simple technical problems such as to identify low battery or inadequate memory.

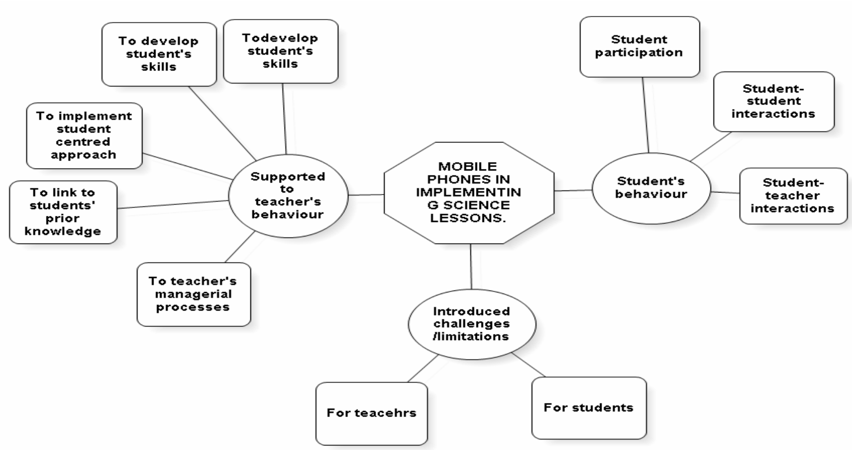

Figure 2 Thematic network –The use of mobile phones

All teachers were concerned about managing time during lesson implementations. They mentioned that time management was a challenge for them, as the students used mobile phones during their group activities. However, the teachers' efforts to complete the student activities within the allocated time for each activity were noticed. Before group activities, the teachers loudly mentioned the time allocated. Further, during lesson 2, the teacher checked the mobile phone of one group to establish whether the group had finished a particular task by viewing the video clips received from the other groups. Thus the mobile phone provided a quick way of witnessing the progress of an activity before moving to the next step.

Resource management skills of teachers, during the lesson implementation helped to utilise the available resources to the maximum with 3 of the 4 lessons conducted using the small group activity approach. This was mainly due to the fact that there were only eight mobile phones available for each lesson.

4.1.2 To link to students' prior knowledge

It was found that during lesson implementation, the mobile phone supported the teacher in connecting the lesson with the student's prior knowledge. For example, during lesson 1, students brought the images of household chemicals (as saved images in their own mobile phone and sent to teacher's computer via Bluetooth facility) to the classroom. The teacher asked questions based on their prior knowledge to classify these images into four categories as detergent, food additives, cosmetics, and medicines. In another lesson when constructing the voltaic cell with laboratory apparatus, different groups used different sets of metal plates. Then they captured the observations as video clips and then each group shared their observation with other groups. As each group had seen the observations taken from different metal plates, the teacher could relate these observations to the 'activity series' which the students had learnt in Grade 8.

4.1.3 To implement a student centred approach

In this research study, all four lesson implementations were based on student centred approaches. For all the lessons teachers incorporated mobile phone functions like still camera, video camera and Bluetooth into students' learning activities. Table 2 summarises the different ways in which the mobile phones were used by teachers to make the lesson implementation more student centred.

4.1.4 To develop students' skills and attitudes:

Further it was noticed that these small group activities provided more opportunities to develop students' knowledge, skills and attitudes during the lesson implementation. Concerning the development of students' skills the teacher who conducted the lesson 3 reported as follows:

Table 2: The different ways in which the mobile phones were used by teachers

Lesson	Stage	How
1	Engagement	Students brought images stored in their mobile phones to the classroom. Students sent their pictures to teacher's computer via Bluetooth.
2	Engagement	Mobile phones provided instructions on constructing a simple voltaic cell as a video clip for the student groups.
	Lesson development	Mobile phones were used to record student groups' observations, to share them with other groups, and to gain information to construct their poster.
	Lesson evaluation	Student groups received teachers' questions, then sent their answers to the teacher and finally received teacher's feedback.
3 & 4	Lesson development	As groups, the students collected information from the garden and brought them to the classroom for learning.

> *"Compared to my previous lessons, this lesson provided more opportunities to develop my students' group working skills, investigation skills, communication skills, leadership skills, management skills, presentation skills and also the skills relating to the use of mobile phone functions. Further it was a good opportunity for them to develop their understanding on the educational potential of the mobile phone"*
>
> (Review Workshop\Video\Day 4\Teacher 13)

Considering the students' attitudes, during lessons 3 and 4 while introducing the learning activity, the teachers emphasised the value of the use of the mobile phone in the lesson as it supported them in bringing the outside word into the classroom without harming the natural environment.

4.1.5 To enhanced teacher-student interactions

During the Review Workshop the teachers who implemented the lessons said that teacher-student interactions had increased during their lessons due to the use of the mobile phones. It was noted that there were face to face interactions and other interactions through mobile phone functions. For example during lesson 2, the teacher used mobile phone video as a medium of instruction to construct the voltaic cell. In the same lesson the teacher used SMS to quiz the students during the evaluation stage. Also during lesson 1, the teacher sent a Photostory to the students' mobile phones with their homework. Further teachers reported that the face to face interaction such as teacher questioning was increased. For example the teacher who conducted lesson 1 reported that he could ask more questions as the lesson was based on the information that students had brought (as saved images) from their home environment. Another example was during the implementation of lesson 4, the teacher questioned the students by directing them to look at the leaf images that students had brought into the classroom as saved pictures.

4.1.6 To evaluate student learning and behaviour

It was noticed that the mobile phone helped teachers to evaluate student learning and behaviour both during and after the lesson. During lesson 2, the teacher evaluated students learning by sending few questions via SMS, receiving answers and also sending feedback through SMS. Teachers who conducted lessons 1, 3 and 4 reported, during the Review Workshop, that they had evaluated students' understanding while viewing the students' saved images on the mobile phones after the lesson. The teacher who conducted lesson 2 said that she evaluated students' behaviour during the group activity as she videoed students' engagement.

4.2 Organising theme: Supported student's behaviour

4.2.1 To enhance student participation

Students' active participation was noticed in all four lessons. For an example in lesson 1, throughout the lesson the students had enough opportunities to participate actively. This was mainly due to the fact that the lesson was based on materials (images) which students brought to the classroom as saved pictures in their mobile phones. Two students stated this as follows:

> *"The lesson was very interesting and different because, most of the things that the teacher discussed were based on our pictures. We all brought those pictures from our house and before getting photos we read the labels. Therefore we answered teacher's questions better than in other lessons."*
>
> (Implementing lesson\Lesson 1\Audio files\ Students' view)

> *"Before getting the picture of Surf Excel [a washing powder in Sri Lanka] packet I read the label. When teacher asked someone to classify it, I went to the front of the classroom and moved the pictures on the computer screen into correct box which was labeled as detergent.".*
>
> (Implementing \Lesson 1\Audio files\Students' view)

Another finding was more students had opportunities to actively participate in their learning activity as the use of the mobile phones increased the number of roles within a group. For example during lesson 3 due to the use of the mobile phones, two roles as photographer and assistant photographer were added to the group roles. Further, the mobile phone based activity emphasised the responsibility of each member of the group by motivating students' active engagement in collaborative activity. For example during the group activity of lesson 2, each member of the group had to conduct the experiment precisely and share their observations (video clip) via Bluetooth within an allocated time period. It was observed that all the group members actively participated in the activity as shown in Figure 3 where two group members are seen holding the metal plates; one fixing the wires to the galvanometer; another is ready to capture the observation on video whilst the last member is noting down the observations.

Figure 3 Students collaboratively engage in the activity

4.2.2 Student-teacher interactions

As students used mobile phone functions during their learning activity, two types of student-teacher interactions were observed. One way was to send the information (that students had) to the teacher for a particular purpose. For example during lesson 1, students sent their information to the teacher's computer and based on that the teacher constructed the lesson. Another example was during the evaluation stage of lesson 2 students sent their answers via SMS to be assessed. The other way is to solve their problems during the learning activity. The teacher who conducted the lesson 2 reported during the Review Workshop as follows:

> *"As I used a video clip to give instruction to construct a simple voltaic cell, I had more time to go around. When students realised that I was available they asked many relevant questions. For example one student asked the possibility of constructing a simple voltaic cell at home"*
>
> (Review Workshop\Video\Day 4)

4.2.3 Student-student interactions:

During the Review Workshop teachers who implemented the lessons said that, as they integrated mobile phones into students' learning activities the student-student interactions had increased. It was noted that there were two types of interactions, inter group interactions and intra group interactions. For an example during lesson 3, student-student interactions were very common as they engaged in the activity collaboratively. The group members' supported (while fulfilling their own responsibilities) capturing the best possible observation (image/video) using their mobile phones. The interactions relating to this were observed as verbal (eg: showing good leaves, asking to zoom and changing the orientation) and non verbal (removing other branches that covered the object to be photographed). The following excerpt and images on Figure 4 provide evidence for these interactions.

During the lesson on ‘environmental relationships’

During the lesson on ‘diversity’

Figure 4 : Other students helping to get a good picture

It was also found that after taking a photograph, the students shared their views about the quality of the picture taken. For example during lesson 4, it was observed that after getting an image they discussed it and decided to get another image. Furthermore, during learning activities, interactions were identified in terms of sharing students’ technical skills and knowledge. During the lesson 2 one member of the group came across a problem while he was trying to video record the observation. As shown in the following excerpt, another member recognised that it was due to the battery running out.

Student 1	*Oh! The video function is not working anymore.*
Student 2	*Why what happened*
Student 3	*Let me see. I think battery is low. Can you see this icon like a battery? It is blinking that means the battery is low.*
Student 1	*Ok. What shall we do?*
Student 2	*Ask teacher*

(Implementing lesson\Lesson 2\ Audio files)

Student-student interactions could also be observed during the latter part of the group activities. This was common observation at the point when students were preparing documents to present (poster/presentation/dichotomous key) using the information that was stored in the mobile phones (as images or videos). Students shared their ideas about the images to complete their task. For example one student who was in lesson 4 reported,

> *“When I was creating the dichotomous key, all my group members stated their ideas while looking at the images of shapes of the leaves. Sometimes we could not remember the names of the plant; then we asked from the other groups by showing the images”*

(Implementing lesson\Lesson 4\Audio files)

Considering inter group collaboration during lesson 2 all groups shared their observations (video clips) via Bluetooth. After sending a video clip to another group, some students quickly went to that group and checked their acceptance of the video clip.

One student expressed her views on her ease of understanding of the lesson as a result of inter group interactions arising from sharing video as follows:

> *“When we were doing our experiment we sent our video clip to other groups and we got their video clips. Without doing the experiments did by the other groups, we managed to get a better understanding and knowledge about what they did.”*

(Implementing lesson\Lesson 2\written document\Students' view)

Similarly during the group presentations in lesson 3 each group showed the images (relationships between the organisms and environment) of their assigned location of the school garden while presenting their findings to the whole class. During an informal interview after the lesson one student said that

> *“I could easily understand other groups’ presentations as they displayed the images while they were presenting their findings”.*

(Implementing lesson\Lesson 3\ Students' view)

4.3 Organising theme: Introduced challenges/Limitations

4.3.1 For students

It was identified that the biggest technological issue was the use of different types of mobile phones during the lesson implementation. As the steps involved in carrying out the same function were different from one mobile phone to another, students within the same group could not share their skills in using the mobile phones and needed to get the teacher’s help when they came across a problem. Two more problems observed were small screen size and the poor resolution of the pictures of some mobile phones. Another problem encountered was the short life time of the battery. During lessons 2 and 3, the battery of one mobile phone ran out. It affected the continuity of students’ engagement as they had to go to the teacher and wait until the teacher changed the battery.

Inadequate memory was also found to be an issue during the lesson on environmental relationships. Then the teacher deleted some video clips that were not relevant to the lesson. During the subsequent Review Workshop, Teacher 6 who conducted the lesson stated that this problem arose due to her inexperience and she should have checked the availability of memory before starting the lesson.

4.3.2 For Teachers

During the lesson implementation teachers had to facilitate students when the students were using mobile phones (this was a novel experience for students). During the Review Workshop the teacher who conducted the lesson 4 reported her encountered problem as follows.

> *"During my lesson students of some groups had a problem sending their images to other groups via Bluetooth. I had to help them to do that"*
>
> (Review Workshop\Video\Day 4)

Even though the teachers tried their full effort to meet the desired outcomes of the lesson within the allocated period of time (80 minutes) it was observed that the teachers in all four lessons required 5-10 minutes of extra time.

Further during the review workshop the teachers described some limitations of using mobile phones for teaching and learning. For the school the initial cost of purchasing mobile phones and paying for packages, insufficient training of teachers in using mobile phones for teaching and learning, and possible distractions leading to the need to impose new rules and regulations were reported as limitations.

5 CONCLUSIONS

Based on the findings it is clear that mobile phones supported teachers' pedagogical actions in a number of ways that focused on the associated use of student centred teaching and learning. Interactions (teacher-student, student-teacher and student-student) and student participation were enhanced. Further, during the learning activities the mobile phone assisted the teacher in creating constructivist learning environments where learning took place through active behaviour of the students capturing information and constructing new knowledge for themselves on the experiences they gained. This knowledge construction was further facilitated by the teacher by connecting the lesson content to students' prior knowledge (by using mobile phone video and image) and correcting misconceptions (video review). However, it was also found that teachers had some technical problems and needed to carry out additional activities (compared to a usual lesson) as a consequence of using mobile phones for lesson implementations.

The main weakness of this study was the use of different models of mobile phones thus imposing difficulties for both teacher and students. Further, these results are based on limited samples of lessons in Sri Lanka and further work should be carried out before making broad generalisations.

6 ACKNOWLEDGEMENT

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SCROLL: Supporting to Share and Reuse Ubiquitous Learning Log in the Context of Language Learning

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Abstract

One of the challenges of CSUL research is capturing what you have learned with the contextual data, and reminding you of them in the right place and the right time. This paper proposes a ubiquitous learning log system called SCROLL (System for Capturing and Reminding Of Learning Log). Ubiquitous Learning Log (ULL) is defined as a digital record of what you have learned in the daily life using ubiquitous technologies. It allows you to log your learning experiences with photos, audios, videos, location, QR-code, RFID tag, and sensor data, and to share and to reuse ULL with others. Using SCROLL, you can receive personalized quizzes and answers for your questions. Also, you can navigate and be aware of your past ULLs supported by augmented reality view. The initial evaluation of applying this system in an undergraduate English course is illustrated. The web-based version of SCROLL is available at http://ll.is.tokushima-u.ac.jp, also two Android free Apps (Learning log for you and Learning log navigator) is also downloadable from Android Market.

Keywords
Ubiquitous learning, ubiquitous learning log object, life log.

1. INTRODUCTION

CSUL (Computer Supported Ubiquitous Learning) is defined as a technology enhanced learning environment supported by ubiquitous computing technologies such as mobile devices, RFID tags, and wireless sensor networks [11]. CSUL takes place in variety of learning spaces, e.g., classroom, home and museum. Also it provides the right information using the contextual data like location, surrounding objects and temperature.

The main characteristics of CSUL are shown as follows [11],

(1) Permanency: Learners never lose their work unless it is purposefully deleted. In addition, all learning processes are recorded continuously every day.

(2) Accessibility: Learners have access to their documents, data, or videos from anywhere. That information is provided based on their requests. Therefore, the involved learning is self-directed.

(3) Immediacy: Wherever learners are, they can get any information immediately. Thus, learners can solve problems quickly. Otherwise, the learner can record the questions and look for the answer later.

(4) Interactivity: Learners can interact with experts, teachers, or peers in the form of synchronous or asynchronous communication. Hence, the experts are more reachable and the knowledge becomes more available.

(5) Situating of instructional activities: The learning could be embedded in our daily life. The problems encountered as well as the knowledge required are all presented in their natural and authentic forms. This helps learners to notice the features of the problem situations that cause particular relevant actions.

One of the application domains of CSUL is language learning. For example, TANGO [10] supports learning vocabularies. The idea of this system is to stick RFID tags on real objects instead of sticky labels, annotate them (e.g., questions and answers), and to share them among others. JAPELAS [10] aims to support foreigners to learn Japanese polite expressions according to surrounded persons and the place. JAMIOLAS [12] supports learning mimetic words and onomatopoeia using wireless sensor networks. Those CSUL applications are intended to be used all the time. This is one of the features of CSUL called “permanency”. However, little attention has been paid to this aspect.

The fundamental issues of CSUL are:

(1) How to record learning experiences that happen at anytime and anyplace.

(2) How to share and reuse them in future learning.

To tackle those issues, LORAMS (Linking of RFID and Movie System) [13] was proposed. There are two kinds of users in this system. One is a provider who records his/her experiences into videos. The other is a user who has some problems and is able to retrieve the videos. The system automatically links between physical objects and the corresponding objects in a video and allows to share it among users. By scanning RFID tags, LORAMS shows the user the video segments that include the scanned objects. Although this system is useful in certain environments, it is not easy to be applied in practice at any place at the moment. Therefore, we started more practical research called "ubiquitous learning log (ULL)" project in order to store intentionally what we have learned as ubiquitous learning log objects (ULLOs) and consequently reuse them.

How are we learning from past learning log? For example, we take notes, e.g., vocabularies, idioms, sentences in a language learning situation (Figure 1). Whereas, they will not remind us of the knowledge learned, nor the situation where the knowledge was used. We think this process can be enhanced using mobile devices. Therefore, this paper proposes a system called SCROLL (System for Capturing and Reminding of Learning Log), which supports the learners to record, share and reuse ULLOs using mobile devices.

For example, if you visit another country, you may learn some vocabulary or culture there. But you may forget what you learned after coming back your home. However, if you record your ULL using SCROLL and visit the same place again, you would be reminded of your past learning log and its context by SCROLL. This paper describes the design, the implementation and the initial evaluation of SCROLL.

Figure 1: Example of learning log.

2. RELATED WORKS

2.1 Life-log

Life-log is a notion that can be traced back at least 60 years [1]. The idea is to capture everything that ever happened to us, to record every event we have experienced and to save every bit of information we have ever touched. For example, SenseCam [4] is a sensor augmented wearable stills camera; it is proposed to capture a log of the wearer's day by recording a series of images and capturing a log of sensor data. MyLifeBits [3] stores scanned material (e.g.: articles, books) as well as digital data (e.g.: emails, web pages, phone calls, and digital photos taken by SenseCam). Ubiquitous Memory system [6] is a life-log system using a video and RFID tags. Also, Evernote (www.evernote.com) is a tool to save ideas using mobile devices such as Android and iPhone. The most common idea of those projects is to use life-log data for memory aid, however, SCROLL aims to utilize life-log data for the learning process.

2.2 Learning log and e-portfolio

Originally, the term "learning log" was used for personalized learning resources for children [19]. The logs were usually visually written notes of learning journals, which could become an integral part of the teaching and learning program and had a major impact on their drive to develop a more independent learner. Research findings indicated that journals were likely to increase meta-cognition and reflective thinking skills through students who become more aware of their own thought processes [17, 18]. Also the term "electronic portfolio (e-portfolio) or digital portfolio" is used for a collection of electronic evidences maintained by a learner. Our approach focuses on how to enrich learning log or e-portfolio, and to promote retention and meta-cognition by using mobile, ubiquitous and context-aware technologies.

2.3 Mobile language learning

One of the application domains for mobile learning is the language learning, because it is based on situated and collaborative activities, that could occur wherever and whenever people have problems to solve or knowledge to share [16]. Especially, vocabulary is basically used for communication [7] and often seen as the greatest source of problems by second language learners (when the students travel, they do not carry grammar books, they carry dictionaries.) [14]. Thus, mobile learning has been identified as one of the natural directions in which language learning is expected to move [15].

Miller and Gildea [9] compared the way children are taught words from dictionary definitions and a few exemplary sentences with the way vocabulary is normally learned outside the school. They noted that people generally learn words outside school. Therefore, SCROLL captures what the learners have learned in- and out-class. Also advanced second language readers can learn more vocabulary when they are given the meaning of unknown words through marginal glosses or when they look up meaning in a dictionary than when no external information concerning unknown words' meaning is available [5]. Therefore, SCROLL provides online dictionary for the learners to find the meaning of unknown words and also gives quizzes increased the learning opportunity. The effect of three annotation types (text-only, picture-only, and a combination of the two) on second language incidental vocabulary retention in a multimedia reading setting was compared [14]. The results indicated that the combination group outperformed the text-only and picture-only groups on the immediate tests. Hence, SCROLL allows the learners to link vocabulary and its photo.

3. SYSTEM DESIGN

3.1 Design

In this paper, ubiquitous learning log (ULL) is defined as a record of what a learner has learned in the daily life using ubiquitous technologies. ULL is considered as a set of ULLOs. The learning can also be considered as the extraction of meaningful knowledge from past ULL that serves as a guide for future behavior [2]. Figure 1 shows the learning processes in the perspective of the learner's activity model called LORE (Log-Organize-Recall-Evaluate).

(1) Log what the learner has learned: when the learner faces a problem in the daily life, s/he may learn some knowledge by him/herself, or ask others for a help in terms of questions. The system records what s/he learned during this process as a ULLO.

(2) Organize ULL: when the learner tries to add a ULLO, the system compares it with other ULLOs, categorizes it and shows the similar ULLOs if exist. By matching similar objects, the knowledge structure can be regulated and organized.

(3) Recall ULL: the learner may forget what s/he has learned before. Rehearsal and practice can help the learner to recall past ULLOs and to shift them from short-term memory to long-term one. Therefore, the system assigns some quizzes and reminds the learner of past ULLOs.

(4) Evaluate: it is important to recognize what and how the learner has learned by analyzing the past ULL, so that the learner can improve what and how to learn in his future. Therefore, the system refines and adapts the organization of the ULLOs based on the learners' evaluation and reflection.

All the above learning processes can be supported by SCROLL.

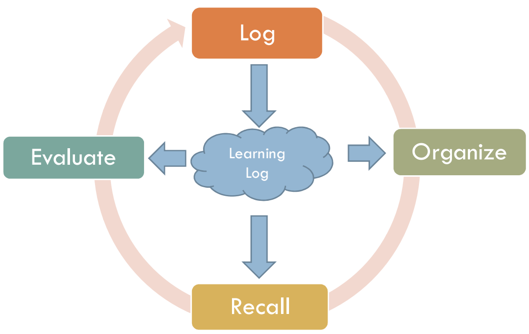

Figure 2: LORE model in SCROLL.

3.2 Linking formal and informal learning

Using this system, teachers can understand what their students learned outside the class (informal settings). For example, they ask their students to record the words that they have learned into SCROLL as ULLOs. In the next class, they make a reflection using their students' ULLOs. Through this process, they can check whether the ULLOs given by their students are correct or not, and allow their students to share their knowledge. In this way, SCROLL enhances and integrates both formal and informal learning.

4. IMPLEMENTATION

SCROLL is a client-server application, which runs on different platforms including Android mobile phones, PC and general mobile phones (Figure 3).

4.1 System architecture

The server side runs on Linux OS and it is programmed using Java and PostgreSQL. The client side is working on Google phone and PC web browser. The developed software for Google phone is a native java application based on Android SDK (Software Development Kit). The users can register and take quizzes by sending a message using mobile phone email like SMS and i-mode.

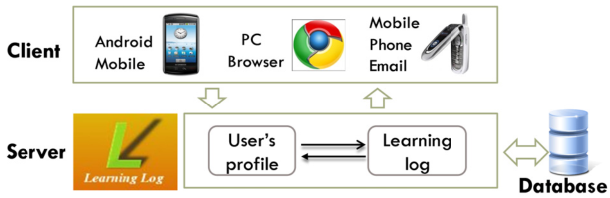

Figure 3: System configuration of SCROLL.

4.2 Database

The database on the server side consists of two main parts:

(1) User's profile: it contains the learner's personal information such as, name, email address, nick name, native language, target language that the user is currently learning.

(2) Learning log object: it contains information about the learning object such as, photo, barcode ID, location, comment, tag and question.

4.3 Android interface

This section describes the Android user interface of each component.

4.3.1 ULL recorder

This component facilitates an easy way for the learners to upload their ULLOs to the server whenever and wherever they learn. As shown in Figure 5(2), in order to add a ULLO, the learners can take its photo, ask questions about it and attach different kinds of meta-data with it, such as its meanings in different languages (English, Japanese and Chinese), comments, tags and location information. Also the learner can select whether the new ULLO can be shared or not.

4.3.2 ULL finder

If learner registers a new ULLO, the system checks whether the same object has been already stored or not by comparing the name fields of each object using a thesaurus dictionary. Also, the learner can search ULLOs by name, location, text tag and time. Using this function, learners can understand what, where and when they learned before. In the future works, the visualization of the ULLOs will be developed.

4.3.3 ULL reminder

The list of the learner's ULLO is shown in Figure 5(3), which helps him to recall all his past ULL. Besides, it allows him to be aware of the others' learning objects and to re-log them; it means that the learner can make a copy of them into his log. Therefore, the learner can obtain a lot of knowledge from the other learners even though he has not experienced that knowledge by himself. By sharing ULLOs with the other learners and re-logging the other learners' ULLOs, the acquisition of the knowledge is enhanced. As shown in figure 5(4), the system generates simple multiple-choice quizzes based on the meta-data of the stored ULLOs. For example, the idea of "quiz with image" is to ask the learner to choose a word to describe the image given by the system. The system immediately checks whether his answer is correct or not. These quizzes are generated according to his profile, location, time and the results of past quizzes and help the learners to recall what they have learned.

The quiz function is designed not only to help the learners to practice what they have learned, but also to recommend what the other learners have learned and to remind them to re-learn their past knowledge according to their current location and their preferred time. In order to achieve these targets, the learner can practice with the quizzes whenever they want. In addition, the client can send the learners' location information to the server all the time. Therefore, the sever side can automatically assign quizzes for the learner based on the location and time information. It notifies the learner to check the quiz by showing an alert message and vibrating the mobile phone. Whenever the learner moves around an area where he has experienced some objects, the system will send him quizzes regarding that objects. Furthermore, the learner can set a time schedule to receive the reminder quizzes.

(1) Add ULLO (2) ULLO list (3) Quiz

Figure 5: SCROLL Interface of Android mobile phone.

4.3.4 ULL Navigator

LL navigator provides mobile augmented reality that allows the learner to navigate through the ULLOs. Like Wikitude [www.wikitude.org] and Sekai-Camera [sekaicamera.com], it provides the learner with a live direct view of the physical real-world environment augmented by a real time contextual awareness of the surrounding objects. While a learner is moving with his mobile phone, the system sends an alert on the phone as soon as entering the region of ULLOs according to the GPS data. This view is augmented, associated with a visual compass, and overlapped by the nearest objects in the four cardinal directions (figure 6, left). Also, it provides the learners with a list of all surrounding objects. When the learner selects one or more of these objects, the Google map will be retrieved, and marked with the learner's current location and the selected objects. Moreover, the system shows a path (route) for the learner to reach to the objects locations (figure 6, right). This assists the learner to acquire new knowledge by discovering the existed ULLOs and to recall his ULLOs. In order to reduce the power consuming of the phone battery, the light-mode (blank screen) is developed. In this mode, the phone camera is turned off, and the system displays only information about the surrounding objects. Moreover, by touching the phone screen, a menu will be displayed; it provides the learners with additional facilities, such as displaying a list of all surrounding objects and photos capturing (Camera-mode).

Figure 6: Learning log navigator (camera view(left); path to ULLOs(right)).

Figure 7: Home page for PC web browser.

4.4 Web interface

Figure 7shows the home window of SCROLL. The user can see the current status of this system, for example, who entered the most ULLO and new entries of ULLO.

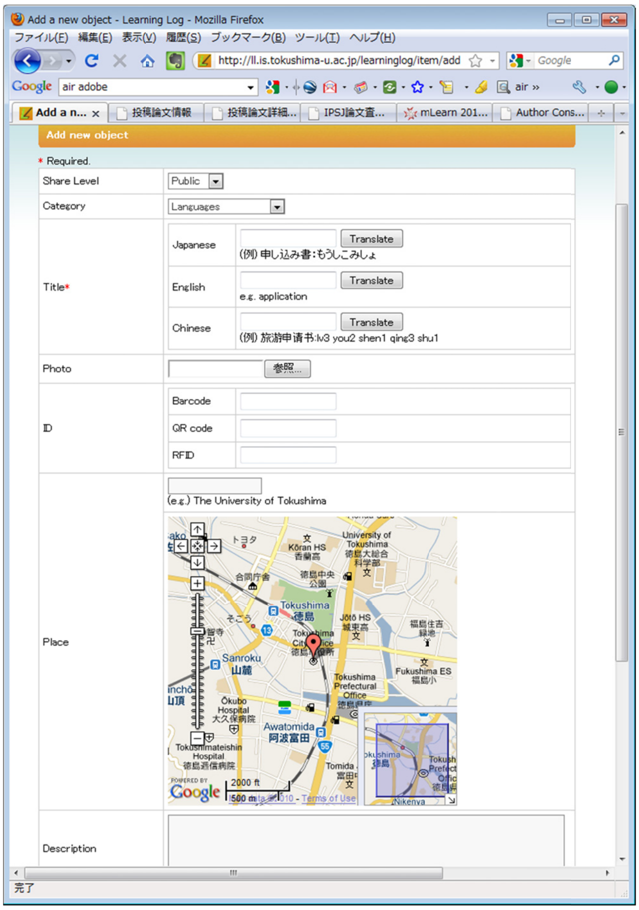

Figure 8: New ULLO.

Figure 8 shows a window for creating a new ULLO. The user can select public or private, and category. Also the user should enter the name of the photo in Japanese, English or Chinese. The word can be translate to another language by translate button. Photo, barcode, RFID can be registered in a ULLO. The location where the photo taken is derived by the Exif data of the photo. Also the user can ask a question to other users by using question item. Then the question will appear in other users' home window.

Figure 9 shows a registered ULLO. If the user pushes "Relog" button, then this object will also belong to the user. Also the Q&A (question and answer) and comments about this ULLO are listed in the window.

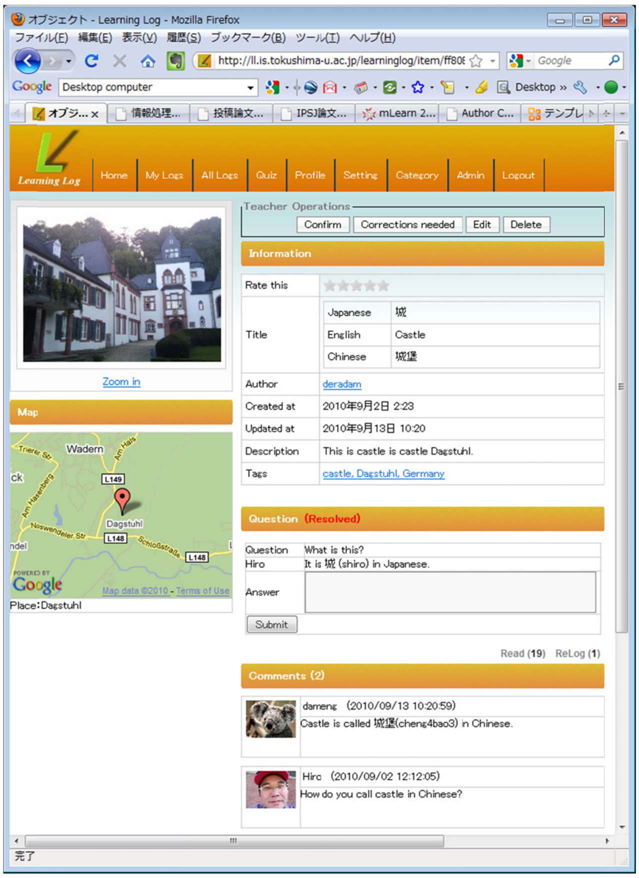

Figure 9: An example of ULLO.

Figure 10 shows the list of all the ULLOs stored in the system. The user can search some ULLOs by title, language, author, tag, date and location. Also tag clouds are shown in the bottom of the window. The list is also filtered out by question or confirmed by teacher.

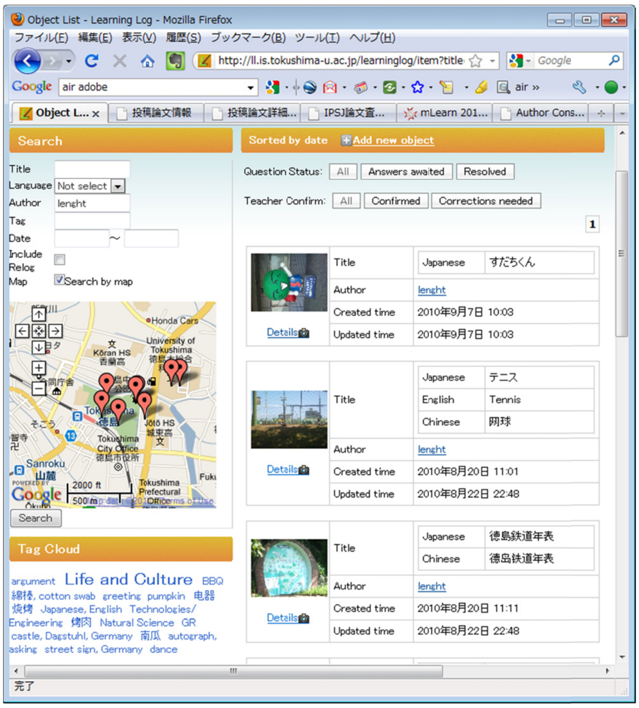

Figure 10: Search results of ULLO.

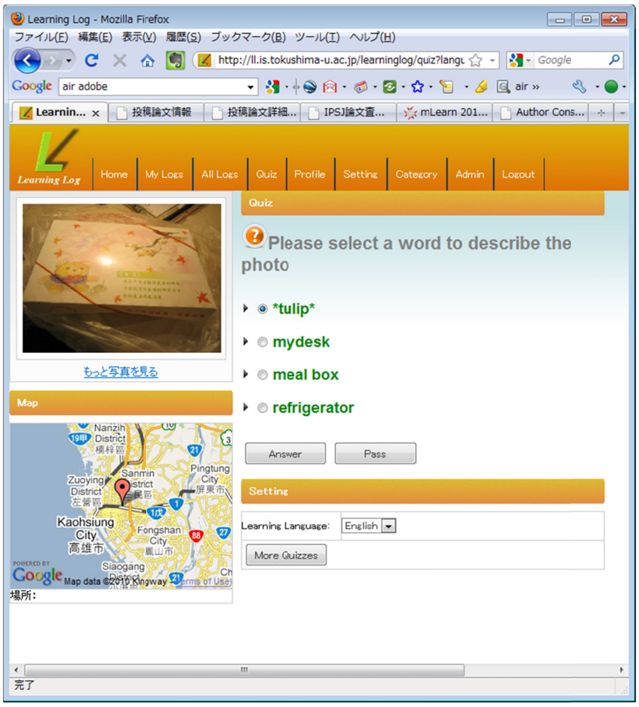

Figure 11: Quiz.

Figure 11 shows a multiple-choice quiz, which is generated by ULLO. If the user pushes the answer button, the right answer will appear. If the user thinks this is not a good quiz, he/she pushes pass button. Then, The quiz will not appear again.

5. EVALUATION

5.1 Method

The study group consisted of 20 Japanese university-sophomores (17 males, 3 females) who were taking the communicative English class at the university. The major of the students was engineering and they ranged in age between 19 and 21 years. All the students underwent an initial test one week before the evaluation started. The test was a 60-item pre-test of words selected by the teacher. They were the names of the things easily found in our daily life such as staplers, rulers, glues, etc. The students were divided into 2 groups with the equal English proficiency according to the pre-test result. Each group consisted of 10 students and engaged in learning vocabulary listed in the pre-test, where Group A used smart phones (7 Sony-Ericsson Xperia and 3 HTC-03A) and SCROLL, while Group B learned the words in a conventional way, e.g., using a paper dictionary without technology. Since Group A has never used a smart phone, about one-hour briefing session was held for Group A students have to help them understand how to use smart phones and SCROLL. Evaluation was carried out over a period of two weeks. At the conclusion of the phase, the subjects underwent a post-test, the same vocabulary test as the pre-test. The full mark for pre- and post-test was 60. Further data was collected from the participants by means of questionnaires and the log data contained in the server.

5.2 Results

Since it turned out that only 5 subjects (hereafter Group A1) out of 10 of the test group used smart phones and SCROLL during the trial, the rest of the 5 subjects (hereafter Group A2) were added into group B in the data analysis. The pre- to post-test differences between the mean test scores for Group A1 (with SCROLL) and for Group B (paper-based, without SCROLL) are shown in Table 1, along with the standard deviations for each test result. The analysis was undertaken using one-tail test. There was a significant improvement from pre- to post-test for both groups. Also, statistically significant difference was detected between A1 and B+A2. This indicates that the A1 students learned new words more efficiently and effectively by using SCROLL. If we look at the students whose pre-test scores were under 21, the pre- to post-test difference in A1' and (B+A2)' were shown in table 1. The mean score of A1' was significantly increased ($p=.006964 < .01$). On the other hand, no significant difference in the pre- to post-test results was found between A1'' students and (B+A2)'' students whose pre-test scores were more than 21 ($p=.39187>.1$). This indicates that vocabulary learning using SCROLL was highly effective for poor performers or beginners compared with high-achieving students.

Table 1: Pre- and post-test results (full mark: 60).

GROUP	PRE-TEST	POST-TEST	PRE AND POST DIFFERENCE	T- AND P-VALUE
A1 (N=5)	M = 19.50 SD = 5.24	M = 53.20 SD = 6.33	M = 33.70 SD = 11.29	t=2.01018 p=.029821*
B+A2 (N=15)	M = 19.50 SD = 4.63	M = 41.00 SD = 12.92	M = 21.50 SD = 11.88	
A1' (beginner) (N=3)	M = 16.17 SD = 1.04	M = 57.67 SD = 2.24	M = 41.50 SD = 3.28	t=2.920406 p=.006964**
(B+A2)' (N=10)	M = 16.90 SD = 2.46	M = 36.85 SD = 12.01	M = 19.95 SD = 12.30	
A1'' (advanced) (N=2)	M = 24.50 SD = 4.95	M = 46.50 SD = 0.71	M = 22.00 SD = 5.66	t=0.289608 p=.39187***
(B+A2)'' (N=5)	M = 24.70 SD = 3.29	M = 49.30 SD = 11.40	M = 24.60 SD = 11.66	

*<.05, **<.01, ***>.1

Table 2: Result of the five-point-scale questionnaire.

QUESTION	MEAN SCORE /5	SD
Was registering ULLO useful for growing your English vocabulary?	3.25	1.49
Was Smart Phone with SCROLL useful for vocabulary learning?	3.13	1.25
Was this system enjoyable?	3.00	1.31

According to the users' logs in SCROLL, the A1 students uploaded ULLO 15.6 times and did quizzes 112.6 times on average. The quantitative data suggest that some serious students engaged greatly with SCROLL for vocabulary learning. The correct answer rate of ULLO quizzes was 92.9%. A slight difference (4.1%) was found in the percentage of correct answers between the quizzes from ULLO uploaded by themselves and by somebody else. The former (96.3%) was better than the latter (92.3%).

The questionnaire result is shown in Table 2. The highest mean score was 3.25 when asked whether it was useful to register a ULLO. From the questionnaire response, there was no student of Group A1 who did not want to share ULL. Also some students commented that it was helpful to see the images uploaded by other students. However, for some students, it seemed troublesome to use them because its short duration of battery or unstable Internet connection. Another explanation for the poor engagement is that even though they received the briefing, some did not understand fully how to use them. These are probably part of the reasons why 5 students of Group A did not show any involvement in SCROLL. Thus our next evaluation is being more carefully planned.

6. CONCLUSION

This paper proposes a ubiquitous learning log system in order to enhance sharing and reusing past learning experiences. The system runs on Web browser, Android and email platform. According to the initial experiment, SCROLL was effective in learning English vocabulary, since statistics shows a significant difference between the control group and the experiment group. Since this system is intended to be used in general domains and for life- long learning, we will apply it in other application domains, e.g., math, physic, and science education and conduct a long-term evaluation with an enough number of subjects in the future work.

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An Activity Theory Analysis of Collaboration in a Mobile Learning Activity

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Abstract

Mobile technology offers new opportunities for collaborative learning in otherwise remote contexts outside of the classroom. A successful realization of these opportunities relies however on that the mobile learning activities provide the supportive structures effective collaboration requires. This paper reports on a study that explores challenges that needs to be met for the design of collaboration support. The collaborative aspects of a mobile geometry learning activity are analyzed from the perspective of Activity Theory. The findings obtained indicate that collaboration can be impaired if: 1.) the functionality needed for collaborative problem-solving is unequally distributed on several mobile devices; 2.) task-related information is not accessible to all learners; 3.) the task structure is not sufficiently complex; and 4.) teacher scaffolding is too readily available.

Keywords

Mobile learning, Collaboration, Activity Theory

1. INTRODUCTION

Mobile technology has the power to enhance collaboration (Pachler, 2010) and bring learners to otherwise remote and authentic contexts for physically engaging learning activities (Sharples et. al, 2007). Surely it would be a desirable scenario if children would learn and collaborate more effectively by just having mobile technology in possession and by being outside of the classroom. Unfortunately, despite the promising opportunities the emerging technologies bring forward, learning and collaboration are not uncomplicated and do not emerge effortlessly.

We know the importance of supporting the learning processes of children, and specifically that learning activities should be designed to provide the supportive structures learning requires. In educational settings, the main source of support (i.e. scaffolding) has historically been the teacher. Nonetheless, while teacher scaffolding has earlier been focused upon extensively (McLoughlin, 1999), the relevance of collaborative scaffolding and collaborative learning has been specially emphasized in the last 15 years, in particular in established fields such as Computer Supported Collaborative Learning (CSCL).

With the emergence of mobile learning, the relevance of collaborative learning has increased even more, not exclusively because mobile technology can enhance collaboration, but also because teacher availability may be an issue outside the classroom. In contexts where there are many children and the distances are larger than in the ordinary classroom, thus with less teacher availability, effective collaborative scaffolding becomes more important.

Successful collaboration in learning activities is however rarely a spontaneous phenomenon but rather the result of structuring and regulation of the learning process (Järväla, 2007). In turn, this give rise to the challenge to structure support for collaboration in more dynamic contexts. Collaboration in such a context can change the conditions for social interactions by constraining the possibility to share knowledge and information (Winters & Price, 2005).

This paper reports on a study addressing the challenge of supporting collaboration in mobile learning contexts. We analyze a mobile learning activity from an Activity Theory perspective, and present empirical findings on how a designed activity system, including mobile technology and other components such as task structures and a non-classroom context, affects collaboration.

2. RELATED WORK

Collaboration is an established theme in the field of mobile learning. In the recent mobile learning literature, the conceptual debates about the opportunities and affordances of mobile technology for collaboration are both frequent and discussed in considerable depth (e.g. Pachler et. al, 2010; Sharples, 2006; Winters & Price, 2005). Simultaneously, a number of studies have utilized the opportunities for collaborative learning with mobile technologies, such as *Treasure Hunt* and *Ambient Wood* (Rogers & Price, 2009).

Although collaboration has been an integral part of several studies, so far it has to a minor extent constituted a research question in itself. As a result, the documented empirical understanding of how we best design support for collaboration in mobile learning activities is relatively small (Stanton, 2002). Put differently, while the discussions about the opportunities of mobile technology fortunately are rich, we still need empirical knowledge about the challenges associated with collaborative mobile learning, and guidance for how to design for effective collaboration.

For the above reasons, we design a mobile learning activity aimed at primary school children with the learning objective to collaboratively practice the mathematical concept of area in outdoor settings. In this context, we ask the question: how does the mobile technology, the non-classroom context, and the activity system as a whole, affect the collaboration of the children? This is an empirical study, exploring how to design for effective collaboration in mobile learning activities.

3. THE MULLE STUDY

The MULLE (Math edUcation and pLayful LEarning) study was held in the autumn of 2009 and aimed at fifth-grade children practicing the area concept, across indoors and outdoors contexts, collaboratively, concretely, physically, and playfully. The children worked in two groups of three children each in four sub-activities: two indoors introductory activities, an outdoor field activity, and an indoors debriefing activity.

The scenario for the outdoor activity of MULLE was that an imaginary, almost extinct, species needed to be relocated from the local wild animal park. The task for the children was to see to that the new enclosures for the animals had the right measurements. Measuring large enclosures required the children to use a mobile software application which measures the distance between two mobile devices using GPS. The outdoor activity started outside the school. The two groups of three children in each group received the mobile devices. After a short introduction they were told to follow the task instructions on the master device which instructed them to go to a meadow on the other side of the woods. On entering the small field, the master device signaled that they were in the right location.

Figure 1: Two areas in the small field and one in the big field

In the small field, they were introduced to the first task and asked to guess the area of two small rectangles marked by plastic cones. The rectangles had different length and width but were both 12 m^2. Each group had prepared one 1x1 meters cardboard square to measure the areas. After a completed task they would send the answer to receive a new task. When they had guessed and calculated the areas correctly they received a message on the master device to go to the big field for the second task.

In the big field, they were asked first to guess and then to measure the area of the large rectangle. The large rectangle had cones to mark the corners and an area of 4000 m^2. A guess within +/-2000 m^2 was considered to be correct. The children groups measured the rectangle by measuring each side of it using the mobile devices. When they had submitted an answer that was within +/- 1000 m^2, they received the third and last task; to go to another field nearby and to create their own rectangle with the area 4000 m^2. The activity ended with the children showing their own area to one of the teachers. At last, the children moved inside to perform a similar activity as the outdoors activity, but this time on paper.

4. ACTIVITY THEORY

Activity Theory is a theoretical framework that aims to explain human beings trough an analysis of the genesis, structure, and processes of their activities (Kaptelinin & Nardi, 2006). The framework uses the concept of activity, which is understood as the subject's purposeful interaction with the world, as the fundamental unit of analysis, and offers a set of concepts that can be used in order to conceptualize activity systems (Nardi, 1996).

Activity Theory has its origins in Vygotsky's (1986) concept of tool mediation and Leontiev's (1978) elaborated notion of activity. Vygotsky (1986) proposed the idea that human beings seldom interact with the environment directly without using cultural artifacts such as technical and semiotic tools as mediators of external activities. This idea was portrayed with a triangular schema of mediated activity (see Figure 2).

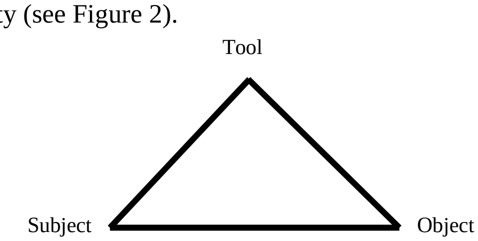

Figure 2: The triangular schema of mediated activity (Vygotsky, 1986)

Vygotsky's ideas about cultural tools as mediators of activities, and in particular the concept of activity itself, were further developed by Leontiev (1981) into the fundamental principles of Activity Theory (Kaptelinin & Nardi, 2006). In addition, Leontiev introduced the concept of the object of the activity and the notion of a hierarchical activity structure. The proposed claims were that all human activities are directed towards objects that motivate actions, i.e. activities are understood as mediators of interactions between subjects and objects (Kaptelinin et al., 1995), and that activities can be analyzed at three hierarchical levels - activity, actions and operations. Actions are conscious and goal-directed undertaken to fulfill the object of the activity, whereas operations are routinized, unconscious and automatic components of actions.

Inspired by Vygotsky's and Leontiev's approach, Engeström (1987) proposed an extended activity system model (see Figure 3), including the subject-tool-object relation of Vygotsky, but with a description of activity as a collective phenomenon, as opposed to Leontiev, who almost exclusively focused on individual activities (Kaptelinin & Nardi, pp. 99). In order to account for the social structure of activities, Engeström (1987) included three additional components: 1.) *rules* that regulate the subject's actions; 2.) *community* of people who share a common object; and 3.) *division of labor* – how tasks are divided between the community members.

In this paper we use the Engeström's activity system model because it: 1.) depicts the constitutive components of tool-mediated and collaborative activities, present in the mobile learning activity focused in the MULLE study; 2.) the notion of division of labor brings the collaborative aspect to the foreground and provides means for making a distinction between cooperative and collaborative processes (Nezamirad et al., 2005); 3.) the hierarchical structure and dynamic transformation between activities, actions and operations facilitate analyzing collaborative activities and cooperative processes within them (Nezamirad et al., 2005). These three aspects, relevant for this study, are not highlighted sufficiently by the Activity Theory-based Task Model for mobile learning proposed by Sharples et al (2007).

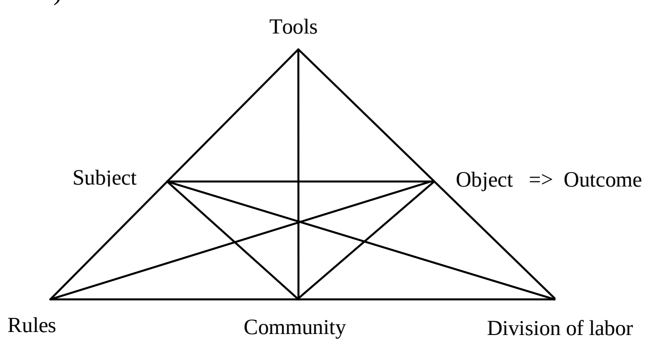

Figure 3: The activity system model (Engeström, 1987)

5. METHODOLOGY

Activity Theory can be used in different ways and for different purposes, and there is no standard method for putting Activity Theory ideas into practice (Nardi, 1996). One of the most powerful and frequent invoked uses of Activity Theory is nonetheless as a lens or orienting device to structure analysis of socio-cultural learning (Barab et al., 2004). In this study, we analyze how the designed activity system affects the collaboration of the participating children. As such, Engeströms activity system model (see Figure 3) has been used as a lens in order to highlight the components of the activity under analysis, namely tools, rules and division of labor, which are assumed to mediate the activity and affect the collaboration. The analysis has been performed in three steps.

As a first step, the collected video data was mined for episodes where the collaboration of the children was weak. The episode selection criteria for weak collaboration were two-folded. Episodes were chosen by paying attention to: 1.) low-participation; and 2.) poor communication conditions. For the selection criteria low-participation, attention was put to episodes in which group members were not at all, or to a minor extent, participating in the problem-solving, seen from both a conceptual and a physical/procedural level. As collaboration also requires good conditions for communication, a focus was directed at episodes where the communication possibilities were constrained, largely due to distance between the children.

As a next step of the analysis procedure, questions were generated from the perspective of the components of the Engeströms model. An example of that is the question: Can the tools used mediate this particular weak collaboration? In order to search for answers to this and other questions, the third step of the analysis comprised of going back to the collected data for further analysis. For instance, by focusing on the use of the tools and paying attention to indicators of their possible influence on the collaboration.

The empirical data of this study was collected through audio- and video recordings. A microphone was attached to each child, and four researchers recorded the activities with cameras from both long and short distance. The total amount of video and audio data was approximately 6 hours.

6. RESULTS

In the following section, we discuss how collaboration was mediated by the activity components. This is presented by three representative episodes. Each one of the episodes represents how collaboration was affected by the design of the mobile learning activity. The first episode describes the activity during the first task. The second describe the collaborative activity during the two final tasks in which the mobile technology was used to a higher extent in the problem-solving process. The third and final episode describes the collaborative efforts of one of the groups, over the course of the whole outdoor activity. In the result section, the names of the participating children of group 1 are replaced with the codes S1, S2, S3, and for group 2, S4, S5, S6.

6.1 Task 1– Task structure

The observations of the first task, measuring a 12 m^2 area, revealed that the children had no significant difficulties solving it. Obstacles were certainly faced, but the problems and the children's conversations were to a large extent related to the at times malfunctioning technology. From a conceptual learning perspective, we observed that one of the children expressed a solution strategy. This strategy was subsequently executed with physical operations by the group member's, primarily without negotiations and explicit reflection within the group. As such, the collaboration process during this part of the outdoor activity could be characterized as a divided strong cooperative work on a physical/procedural level and a weaker, or non-present, collaboration on a conceptual level. Considering the observation that the task was quite effortlessly completed, we think that a less complex task structure may mediate a division of physical labor and inhibit a need for externalizations of thoughts and collaboration on a conceptual level (see Figure 4).

If the learning objective for an activity is concept development, which it in this case was, and collaborative discussions concerning the chosen concepts is assumed to facilitate that process, more attention has to be put on the design of the learning tasks. The tasks must be complex enough, not only in a way that it encourages a division of physical labor and collaboration on a procedural level, but in addition, as a mean to create a need for discussions on a conceptual level.

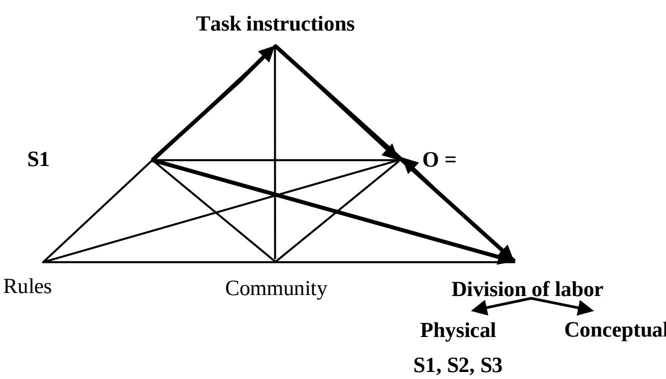

Figure 4: Activity model - Task 1

6.2 Task 2 – Mobile tools

The last two tasks involved areas of rectangles of much larger size, 4000 m^2, than in the first task (see Figure 1). This meant that the sides of the area measured were much longer and required more use of the mobile devices and in particular the GPS distance measurement functionality. The measurements of the sides of the rectangles were performed as follows. One of the children positioned herself at one of the ends of the sides with the master device while the other two placed themselves at the opposite side of the rectangle with the secondary device. With the master device, the children could receive task instructions, send in and receive answers, obtain feedback, and start and redo measurements. The secondary device contained clues. When doing a measurement, both devices GPS coordinates were identified, the distance calculated, then sent and presented on the master device.

The distribution of the devices and the functionality they contained had consequences on the collaboration. During the last two tasks, we observed that the child with the master device was the most dominating group member who defined strategies, did adjustments and directed the others through the tasks. This was the case in both of the participating groups. After an analysis of the last two tasks, we interpreted that the tools used in the activity together with their distribution structured a division of labor on two levels; namely, a conceptual and a physical (see Figure 5).

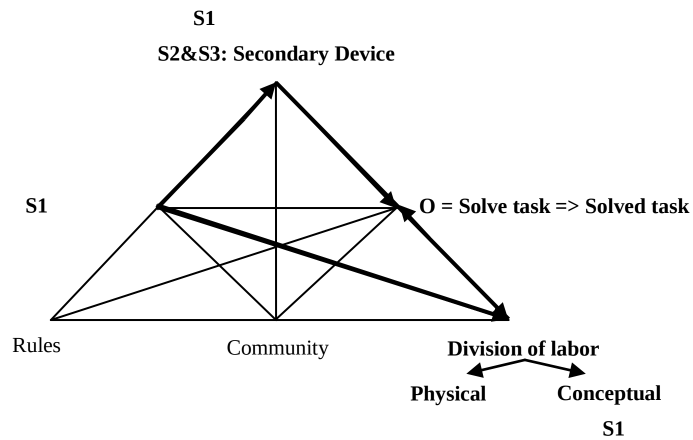

Figure 5: Activity model - Task 2 and 3

From a learning perspective, the child with the master device in possession (S1) was to a large extent the only one working on and consequently with more possibilities to learn on a conceptual level. By being the only one receiving the distance results on her device, while S2 and S3 were not in communication distance from her, she was also the one being most aware of the task progress, of eventual need for adjustments, choice of goals and actions or change of strategies. When adjustments were needed S1 signaled to the others what they should do and where they should go. S1 was connected to the learning process to a much higher degree than the other two, who in a sense, were functioning as her tools in the activity by carrying out the ordered physical labor and basic operations, using the secondary device.

Collaboration and learning for all group members on a conceptual level, was thus inhibited as a consequence of the large distances between the children and the restricted communication possibilities, combined with the unequal distribution of tools and tool functions. In order to facilitate that all children are participating in the learning process and able to collaborate, not only by dividing the physical labor but also sharing the conceptual, all functions needed for the conceptual learning process should be made available for all of the participating children. In practical terms, this may have the following design recommendations: 1) Utilize the communication capacity of the mobile devices. 2) Functions needed for both procedural and conceptual learning should be integrated and distributed equally if there are several devices. All children should be able to monitor the task progress, and there should be equal distribution of task-related information.

6.3 Whole activity – Teachers as tools

As described previously, the task structure and the distribution of the tools were two probable factors that affected the collaboration of both of the groups. We could, however, observe differences between the groups regarding the collaboration dynamics during the whole activity pointing at other possible influential factors. While the children of the first group were all engaged and active during the whole activity, even if a conceptual and physical division emerged, two of the children in the second group (S5 and S6) became more passive and less engaged as the activity progressed. In addition, we could observe that group 2 had more contact with the teachers than the first group, and that S4 in particular, who was the dominating child in group 2, received the most help. Moreover, we observed that S6 directed insulting comments towards S5 at several occasions.

The reasons to why two of the children became increasingly passive could have been many. In either case, two possible contributing factors have been identified, the use of the teacher as a tool and the absence of social rules. We believe that the exclusion of S5 and S6, to some extent, was enabled by the teachers constantly meeting the information needs of S4 instead of directing her to the group and thereby encourage collaborative problem-solving (see Figure 6). The insults on the other hand emphasized the need for social- and collaboration rules. We as the designers of the activity did not provide this. In addition, more attention should have been put on the formation of the groups, taking the individual social history and individual knowledge levels into consideration.

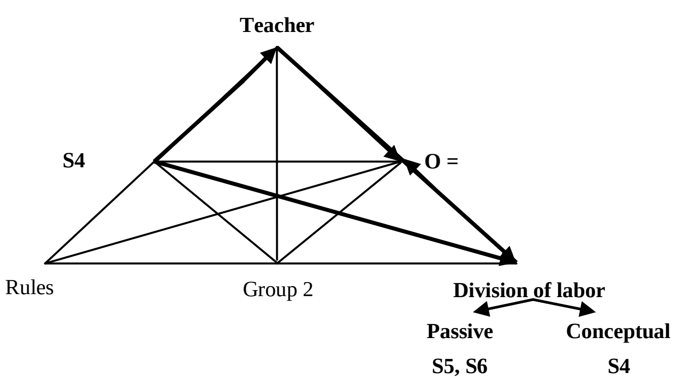

Figure 6: Activity model – Whole activity

7. CONCLUSIONS

It is claimed that mobile technology has the power to enhance collaboration (Pachler, 2010). It is also claimed that tools changes the nature of learning (Traxler, 2007; Kaptelinin & Nardi, 2006), that new m-learning contexts can change the conditions for social interactions (Winters & Price, 2005), and that successful collaboration needs structuring and regulation of the learning process (Järväla, 2007). The results of this study can confirm almost all of these claims except of the first one. Mobile technology may have, and we believe that it most likely does have, the capacity to promote collaboration. However, the findings of this study indicate that the incorporation of technology can strongly constrain the possibilities for collaboration and learning.

In MULLE, the children in possession of the master device, with all functionalities needed for problem-solving, became to a much higher extent responsible for both the conceptual thinking and the definition of goals and strategies, while the other children's effort were reduced to basic operations and physical labor with restricted possibilities to monitor the problem-solving process. What we achieved with this particular distribution of tools was a division of labor characterized by cooperation: "an activity where each person is responsible for a portion of the problem solving" (Roschelle & Teasley, 1989), and not collaboration: "... a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem" (ibid.).

Put differently, what we did not achieve as a consequence of the distribution of the mobile device functions, in combination with the constrained communication possibilities, was the participation of the children in what Roshelle & Teasley (1989) describes as the "Joint Problem Space", consisting of agreed goals, actions, and descriptions of the current problem state.

In order to facilitate collaboration, and include all in the process of concept development and acquisition of procedural knowledge, the analysis in this paper implicates the following recommendations for the design of collaborative mobile learning activities:

Monitor the task and problem-solving progress

To facilitate the creation of a Joint Problem Space, in particular in activities that involve several mobile devices with different functions, access to information related to the task and its progress should be provided to all participating learners in order to create conditions for task awareness and engagement.

Utilize the communication capacity of the devices

If the nature of the task creates distances between the learners, that hinders communication, even though it is under short episodes, allow for the learners to use the communication capacity of the devices enabling them to negotiate and adjust goals and actions.

In addition, the analysis of this paper resulted in the identification of the task structure, the teachers and the absence of social rules, as being factors having a negative impact on the collaboration. Clearly, if the task is too trivial a need for negotiations and common reflections will not be created, which confirms Arvaja et al. (2000) who concluded that the nature of the task is a crucial determinant of successful collaboration. Furthermore, while the teachers certainly can play an important role in the field, it became evident that they can hamper the collaboration as well, if teacher scaffolding is too readily available thus diminishing the scaffolding roles of the group members.

As concluding remarks, regarding the use of Activity Theory in general, and in this case, Engeströms activity system model in particular, we view the analysis tool as providing a good starting point for understanding the collaboration process in mobile learning activities. As a tool, and a lens, it was able to: 1.) highlight relevant aspects of the activity, such as the tools and division of labor; 2.) aid the generation of questions for further inquiry; and 3.) provide concepts and a language that facilitated both the analysis and its presentation.

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Mobile Device-Based Library to Support Health Care Delivery and Continuing Medical Education in Low-Resource Environments

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Abstract

This paper describes the planning, implementation, measurement, and evaluation of an applied research project in the use of mobile computing devices to support access to information and professional development in a low-resource environment. Using newly developed software, a library of clinical information resources relevant to the delivery of health care by nurses in the Eastern Cape Province, South Africa was formatted to optimize viewing on a commercially available smart phone. Devices equipped with this library were deployed to nurses who were trained to access and use the information resources and standard productivity applications on the mobile phones to support their daily clinical activities.

Keywords

Mobile Clinical Library Medical Education

1. INTRODUCTION

The Mobile Health Information System was designed to build the capacity of health workers in resource-poor urban health care settings to care for their patients by providing them with locally relevant, reliable, and accurate clinical information at the point of care through the deployment of smart phones. As implemented at the Port Elizabeth (South Africa) Hospital Complex, the information resources accessible on the smart phones include digitized medical guidelines, protocols, diagnostic tools, drug formularies, and other actionable evidence-based medical information. The primary goal of this project is to contribute to the improvement of health care by introducing a cost-effective system for the dissemination of current, relevant information to support the delivery of comprehensive care and to build nurses' knowledge and skills through the provision of continuing medical education and professional development materials

2. PROBLEM STATEMENT

The inability to access medical and health information hobbles healthcare providers in the world's poorest countries. Due to poor communications infrastructure and prohibitively high cost, doctors, nurses, and public health workers in Africa, Asia, and Latin America do not have recourse to the fundamental health information required for good practice and sound decision-making. (Pakenham-Walsh, et al.) Beyond the issue of financial exclusion, much medical information heretofore developed is irrelevant in the world's poorest regions, which lack facilities and funds for widespread laboratory testing and up-to-the-minute treatment. (Lown and Bannerjee) The preponderance of information which is not applicable and the lack of affordable broadband access render the Internet, an otherwise rich resource, ineffectual in these environments. (Roberts, et al.)

The difficulties resource-poor countries have in providing adequate healthcare to populations living with HIV/AIDS and chronic diseases such as tuberculosis and malaria are exacerbated by the concomitant mass emigration of skilled health professionals in search of higher pay, career advancement, and better working conditions in Europe and North America. (Kinfu, et al.) In addition to the loss of public educational investment and intellectual capital (Hagopian, et al.) the developing nations suffer from a reduced range of available services, chronic understaffing of health facilities, and ever diminishing healthcare services. Increasingly, the burden of providing care to the world's poorest populations falls on nurses rather than doctors. Enhancing these nurses' access to clinical information, and increasing the timeliness and accuracy of this information, are elements vital to improving health service delivery.

3. PROJECT GOALS AND OBJECTIVES

The project, which is ongoing, is investigating whether access to relevant clinical information at the point of care has an impact on nursing practice. The primary goal of the project is to gain greater understanding of how clinical nurses use information available on the mobile devices, and if and how access to clinical information available to them through the Mobile Health Information System (MHIS) changes their patient care behavior. To achieve this goal, project partners set the following objectives:

1. To build the capacity of clinical nurses to use mobile devices to access clinical information;
2. To build the capacity of clinical nurses to use health information in caring for patients;
3. To determine if clinical care of patients changes as a result of nurses' access to information; and

4. To build the capacity of local partners to incorporate information and communications technology in their health care initiatives.

These objectives correlated closely with the South African Department of Health's recognition of the importance of developing adequately trained staff capable of utilizing the most up-to-date syndromic management guidelines. They also support the country's National Strategic Plan which calls for strengthening the health information system at both the provincial and national levels. The Eastern Cape Province Department of Health has set as strategic goals the strengthening of departmental information systems to enable information use for decision-making and the development of effective IT and telecommunications platforms to support the department's service delivery and management. A major objective is the implementation of a comprehensive continuing provider development program accessible to all health professionals throughout the province.

4. METHODOLOGY

In a pilot project funded by the John M. Lloyd Foundation field-testing a handheld computer pre-loaded with essential information for treating HIV-infected and AIDS patients in South Africa, we demonstrated the efficacy of the approach. The tool (using personal digital assistants or "PDAs") was tested at The Valley Trust (in KwaZulu Natal) and met with strong positive response from nurses who had little or no access to current information resources (either printed or digital) or to reference materials. The "AIDS PDA" provided both at the point of care.

Having gained useful and actionable information through the testing of this tool for providing locally relevant HIV/AIDS data and information, the next step in the evolution of the Mobile Health Information System was to implement the changes indicated in the pilot to increase its effectiveness and to enhance its efficacy as an information resource for clinical nurses in urban healthcare settings, and to implement a larger scale deployment to this target audience.

To determine which health care information and continuing provider development materials would be most useful, we conducted a survey of the information needs among clinical nurses at the three hospitals which comprise the Port Elizabeth Hospital Complex (PEHC). We created a quantitative survey tool designed to capture data about nurses' demographics, education, prior experience with technology, current sources of clinical information, and areas of interest for expanded clinical knowledge. The survey instrument was distributed at random to 250 PEHC nurses; completed responses were received from 136. Project staff aggregated and analyzed the collected data and used this assessment to identify the clinical information resources nurses would find most valuable.

An integral component of the Mobile Health Information System is GUIDE, a content management system that AED-SATELLIFE designed and developed to automate the conversion of large documents to format optimized for viewing on the small screen of the smart phone. Previous efforts to present such documents, often heavy with graphs, tables, charts, and other graphic elements such as bulleted lists, yielded disappointing results and consumed vast amounts of human resources to perform hands-on editing. The newly developed GUIDE component was successfully employed to render the Eastern Cape Department of Health (ECDOH) Standard Treatment Guidelines, nearly four hundred pages in length, on to a smart phone nearly perfectly and at considerable savings of time and money. The development costs for GUIDE were about equal to the estimated cost of converting a single document by hand and will be employed again and again for future document conversions for this and other projects.

Using GUIDE, we prepared a digitized Mobile Library consisting of medical guidelines, protocols, diagnostic tools, drug formularies, and other actionable evidence-based medical information. In print, this represented several thousand pages of text and graphics. The documents in the Mobile Library were organized to reside in one location on the device and to be accessible via a Table of Contents page that could be easily launched from one icon on the main screen of the smart phone. Documents were hyperlinked from the Table of Contents page for easy navigation and location of specific information. Once completed, the entire library was easily loaded onto the main memory of each of the mobile devices to be deployed as well as to each phone's microSD card for backup purposes.

AED-SATELLIFE's past experience in deploying mobile computing devices in health care settings indicated that extensive training would be required to ensure that users fully understood the tools and how to apply them. Our approach stressed initial and ongoing in-service training on both the functionality of the device and how to access the clinical information it holds for application to everyday health care delivery tasks at PEHC. 50 nurses were chosen by supervisory staff from a broad spectrum of clinical specialties reflecting the comprehensive care environment of the PEHC including Outpatient, Medical, Surgical, Paediatrics, Gynaecology, Obstetrics, and Casualty. These nurses participated in two-day training sessions that introduced them to the new technology, to the use of the mobile device and its standard productivity applications such as calendar and contacts, and instructed them on how to use the device to access the information in the Mobile Library. In addition, PEHC information technologies staff received separate training to prepare them to provide on-site user support for equipment and applications.

To ensure that the Mobile Clinical Library was meeting the needs of the intended users and to encourage users' long-term engagement with the information tool, project staff reached out frequently to clinical nurses.

Within two weeks of the project's launch, nurses began to receive regular visits from project staff offering support, providing instruction, and gathering feedback to inform future nurse training sessions and the development of additional content. Over time, each hospital's information technologies staff took over these support sessions. A brief survey of the user's individual experience and use of the device was taken at these meetings, each of which concluded with a request for suggestions for clinical content to be added to the Mobile Health Information System.

5. MEASUREMENT AND EVALUATION

The Nursing Sciences Department of Nelson Mandela Metropolitan University conducted an evaluation of the project, the objectives of which were to assess the efficacy of the training provided to the nurses on using the mobile device; the ability of the nurses to use the mobile device to access information; the usefulness of the information provided on the mobile device; and the application of the information stored on the mobile device in practice at the point of care.

A quantitative, descriptive, and contextual survey using a self-administered questionnaire was conducted among the nurses who received training and a mobile computing device as participants in the project. The response rate for this evaluation research study was 82%. 45 questionnaires were distributed by the researchers to nurses at the three hospitals, 37 questionnaires were completed and returned. In addition to self-reporting data, an objective observational evaluation was conducted with a sample of randomly selected nurses. The direct observation exercises aimed to assess the nurse's competence in performing a set of exercises on the mobile phone. 25 nurses participated in the structured direct observation; reporting sheets were completed for each by the observers.

5.1. Self-Administered Questionnaire

5.1.1. Demographics

The questionnaire collected demographic information on the nurses participating in the project. Of 37 respondents, 36 were female and one male, an accurate reflection of the gender profile among nurses in South Africa. 73% were between the ages of 45-49 years, 18% less than 44 years, and 3% 60 years or older. Perhaps a reflection of their age, 68% of the respondents indicated that they had not undergone any training in basic computer applications such as MS Word, Excel, PowerPoint, etc. Only two nurses had received computer training as a part of their basic nursing qualifications.

5.1.2. Training

All participants in the pilot received two days of training on the use of the mobile device and its applications, and on locating and viewing clinical content on device. 81% of the respondents were satisfied with the two-day training sessions. On a scale of very good to very poor, 84% viewed the training received to be very good or good while 16% found it to be average. None found the training to be poor or very poor. This finding indicates that the format (interactive methodology, hands-on exercises) and content of the sessions were satisfactory.

However, while 95% of the respondents indicated that the information provided at the training sessions was either adequate, very adequate or extremely adequate an almost equal number of respondents indicated that they found the information provided at the training to be easy (19) as found it to be difficult (18). Not surprisingly given the lack of prior computer experience and the introduction to a brand new technology, 35% of the nurses indicated that after the initial training they were not confident in their knowledge and skills regarding the use of the mobile device. 73% of the respondents indicated they felt the need for more training. Nurses reported that the training session facilitated bonding among MHIS participants and fostered the seeking and providing of peer-to-peer support when problems were experienced in operating the mobile computing devices.

5.1.3. Use of the mobile device

57% of nurses found the device to be user friendly and a time saver, and the information easily accessible. Overall, 81% of the respondents found it easy to extremely easy to retrieve information from the mobile computing device; 18.9% reported having experienced difficulty. Specifically, 72% located information in the Essential Drug List easily, 81% in the Eastern Cape Disease Directory, 70% in the Standard Treatment Guidelines. Almost 30% of the respondents indicated they found the medical calculator the most difficult application, but 38% found it easy to use. The applications used most frequently were Internet Explorer to search the Internet (57%), short messages service (SMS) or text messaging (43%), and electronic mail (32%).

Reasons given for the difficulties encountered accessing various content types included nurses' lack of computer literacy, lack of time to practice, and lack of understanding of procedures. In addition, some 46% of the respondents considered technical problems to be the major issue in retrieving information including instances when the wireless telecommunications service's server was inaccessible for searching the Internet or for sending email messages.

Among the information resources available on the mobile device, those most often cited for use included the Eastern Cape Disease Directory (87% of nurses), the Standard Treatment Guidelines (73%), the Essential Drug List (54%.) 57% of the respondents indicated that they very frequently accessed information at home and 46% while on duty in the ward but not with a patient. 43% reported that they accessed information at the point of care but not in view of the patient and 32% accessed information while on break. 35% of the respondents indicated they spent more than 10 minutes but less than

30 minutes researching clinical questions, 30% spent more than 5 minutes but less than 10 minutes, and 27% spent more than 30 minutes on average per session. This finding highlighted the value of the mobile library as an educational and reference tool that nurses can easily consult when relevant information is needed.

During most working days, clinical information on the device was accessed by 43% of the nurses occasionally and 27% frequently; 24% reported that they accessed information fewer than five times each week. 89% of the respondents indicated they consulted the smart phone for clinical information with varying frequency most days away from work. This was a significant finding that highlighted the fact that the portability of the mobile device enabled nurses to use the reference material when away from the hospital work setting.

These findings on the use of the information addressed a major objective of the pilot project which was to create a health library on the mobile device that nurses could refer to at any time in caring for patients. Portability and an ample storage capacity for a large library of documents contributed to the usefulness of the mobile device. The power and potential of the mobile device as a tool for continuing medical information was evident in the high percentage of nurses who used their smart phones to expand their clinical knowledge even outside of the work environment.

5.1.4. Use of information in nursing practice

The questionnaire posed questions related to the nurses' application of the information accessed on the mobile device in their daily nursing practice. 89% of the respondents indicated that nursing practice was enhanced by making information accessible at the point of care. They reported that access to health information at the point of care improved their clinical nursing practice in the following ways: 89% of nurses were able to up-date their knowledge on management and treatment of various conditions, 70% provided relevant, up-to-date information to patients, 68% empowered patients with knowledge of their diagnosis and treatment, and 68% enhanced their own knowledge and ability to recognize drug side effects. When queried about sharing information on the device, 89% shared with other nurses, 51% with junior staff, 32% with doctors, and 24% with hospital administrators.

These findings were significant as they addressed a major goal of the pilot project, indicating that nursing practice can be improved by providing relevant health information using appropriate and suitable technology. Not only were nurses able to provide better care for their patients, but they were also able to support their own professional development with a readily accessible library of accurate and reliable information.

5.1.5. Overall experience using the mobile device

When asked to report on their overall experience of using the smart phone, 92% of the respondents said it was helpful to carry the mobile device, 84% found the content easy to read, and 57% wanted the ability to print information from the device. 11% said they preferred to read content on paper. 100% of the respondents indicated they would continue using the mobile computing device upon completion of the project and 92% of the nurses indicated that they would be willing to purchase their own mobile device if they did not already own one. Doctors, other nurses, and patients viewed the mobile devices favourably when used by the nurses in the project. Nurses reported anecdotally that hospital colleagues not participating in the MHIS pilot stated that they wanted to own such a device, be included in the project, and were impressed by the information on the device.

5.2. Structured Direct Observations

The direct observation exercise related to the use of various programs and features on the smart phone aimed to assess the nurse's proficiency in performing a set of tasks on the mobile device as well as their ability and level of comfort in navigating the pre-loaded health content. While the self-administered questionnaire relied on the self-reported subjective experiences of the nurses, the direct observation exercise was designed to provide a more objective assessment of the nurses' proficiency in the use of the mobile device. All the exercises were based on procedures with which the nurses had familiarity and regularly practiced during their weekly training sessions at each of the hospitals.

The researcher used an interview-guide approach together with a structured direct observation checklist comprised of a set of practical exercises with specific commands that needed to be performed. The participants were required to follow the commands and perform the exercises under the direct observation of the researcher and some fieldworkers. A total of 25 respondents participated in this process. Participants were asked to perform certain tasks (launching the Table of Contents page, locating specific health content on the phone, navigating to the storage card on the phone, and using messaging features) while their performance was observed. Structured direct observation sheets were completed for each participant by the observers. The data obtained enabled the researcher to assess whether the respondents were competent in using the various programs on the mobile computing device.

5.2.1. Launching the table of contents page

68% of the participants could competently launch the Table of Contents page from the icon on the main screen while 32% appeared to be unsure.

5.2.2. Locating health content on the phone

Respondents were asked to locate the recipe for a home-made oral rehydration solution. 68% of the participants could competently locate the recipe for the home-made oral rehydration solution to treat diarrhea in the Eastern Cape Disease Directory document in the Mobile Library, 20% appeared to be unsure how to do this task, and 12% were not yet competent. Respondents were then asked to locate the local wound care treatment for diabetic foot ulcers. 44% of the participants were able to competently locate the appropriate information in the South African Hospital Level (Adult) Standard Treatment Guidelines document, 44% appeared to be unsure, and the remaining 12% were not yet competent. Lastly, respondents were asked to name the document that they most frequently used on the phone and then locate it. 88% of the participants could competently and quickly locate the document that they had identified as the one they most frequently used; 12% were not sure.

5.2.3. Navigating to the storage card

64% of the participants could competently locate the Storage Card, 20% appeared to be unsure, and 16% were not able to complete the exercise.

5.2.4. Using messaging features

96% of the participants could competently check for new e-mails, open messages, create and send a new e-mail message, and then close the messaging application. Only one participant appeared to be unsure of how to perform this exercise.

6. CONCLUSION

The overall results of the evaluation of the Mobile Health Information System pilot project indicate that nurses at the PEHC have enthusiastically embraced the new mobile technology, found the training to be adequate, make regular reference to the health information on the device, and use the information to improve their nursing practice. The nurses have integrated the use of the smart phone into their daily activities and consult the clinical information on the device on a regular basis as they care for patients. The nurses were positive about their use of the communication tools on the mobile device such as email and SMS to connect with colleagues both within South Africa and internationally, and for searching the Internet for health information. Although they were not stressed in the training, many of the nurses built skills in use of productivity applications and other functionality built in to the smart phone including calendar, contacts, notes, calculator, and the camera. Health workers should be trained and encouraged to use these tools to support their practice.

The evaluation demonstrates that nursing practice can be improved by providing relevant health information using appropriate and suitable technology. Overwhelmingly, the nurses who participated in the pilot found that their practice was enhanced by the accessibility of information. They reported that the mobile device changed their behaviour in several ways, most significantly by allowing them to readily find answers to questions, gain new knowledge, or refresh their memories regarding diagnosis, management, and treatment of conditions and diseases. Additionally, nurses found that the presence of the mobile device enhanced their ability to empower their patients with knowledge of their illness.

Demystifying the use of technology was a major concern for project partners. Most of the nurses had no prior computer experience; only two of the younger participants had had computer training during their nursing studies. Many nurses had had only limited experience using mobile phones. As a result, the volume of content that needed to be covered during the two-day training workshops was great and most nurses found that the information presented was challenging. Despite their eagerness to learn and develop new skills, at the commencement of the pilot the nurses' lack of confidence in the use of the mobile device was evident. The evaluation results confirm that ongoing, regular training and easily accessed technical support are critical to the adoption of new and unfamiliar technology and to the realization of the power and potential of that technology. It is anticipated that the emerging generation of nurses will be increasingly more mobile-savvy than those who participated in this pilot, may require less training and technical support, reducing the up-front costs of implementing a similar information system.

The introduction of the mobile phone as a tool for information access and exchange has sparked a genuine desire for more knowledge and increased communication with nursing peers. Many of the nurses have joined - and actively participate in - email-based discussion groups. Both the evaluation and anecdotal evidence support the finding that the availability of ready access to information has generated a pattern of knowledge-seeking behaviour and life-long learning among many of the participants. Given that the majority of nurses were 40-59 years of age and had educations limited to single diplomas in nursing, the positive acceptance of the mobile device as a tool for point-of-care information access, professional development, and continuing education in a wide range of clinical topics was a significant finding.

Project results suggest that ministries of health in low-resource environments should consider deployment of mobile devices and the use of wireless telecommunications technologies to improve patient care through the provision of point-of-care access to clinical information and continuing medical education.

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The Mobile Content of the Research Methodology Course for the Post-Graduates

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Abstract

In the mobile technology revolution, people are increasingly connected and are digitally communicating with each other in ways that would have been impossible to imagine only a few years ago. As mobile connectedness continues to sweep across the landscape, the value of deploying mobile technologies in the field of teaching and learning seems to be both self-evident and unavoidable. The use of Personal Digital Assistant- based (PDA-based) performance tools to support classroom instruction has been well under way for a number of years. Taking this into consideration, the Faculty of Education, Universiti Kebangsaan Malaysia has designed and developed mobile content for the Research Methodology course for the post-graduate programme that adopts the mobile learning (m-Learning) concept to supplement the face-to-face instruction. This paper reports the study on students' acceptance of the mobile content developed for the Research Methodology course. A total of 120 post-graduate students responded to a self-report questionnaire on student acceptance of the mobile content developed after participating in series of m-Learning activities. The findings showed that the students agreed that mobile content developed had successfully enhanced the Research Methodology learning process. The study also revealed that mobile-learning activities are effective ways to motivate students and to foster interaction. A main implication of this study is that mobile content needs to be extended to other post-graduate courses.

Keywords

Mobile learning (M-learning); post-graduate students; mobile content; research methodology; acceptance

1. INTRODUCTION

The use of wireless mobile technology such as PDAs, cellular phones, ipods or ultra notebook computers in education and training is making learning more flexible where students can learn from anywhere and at anytime. Mobile learning is defined by various researchers with a focus on the novelty and development of handheld technologies, such as mobile phones, and wireless technologies, such as laptops, allowing easy access to resources. Laouris and Laouri (2006) describe the move from e-learning to m-learning as a revolution since it implies not only a change in terminology but a change of mindset when designing and planning learning environments and goals. Sharma and Kitchens (2004) assign this unavoidable change in paradigm to the unique facilities provided by mobile technology such as the provision of communication facilities at any time or location and the provision of learning content dynamically dependent on the learner's location, context and device. This necessarily implies a change in classroom culture. It is also clear that the exposure to a greater variety of media is causing a different kind of learner who gathers and processes information differently. Mellow (2005) describes this new generation of learners as the media generation. According to him, educators should explore the possibilities of applying these technologies in educational settings.

This paper reports a study on the mobile content developed for the post-graduate Research Methodology course in the Faculty of Education, Universiti Kebangsaan Malaysia. The students were exposed to an exploration of this new field of mobile learning (m-Learning) by participating in series of m-Learning activities developed. The blended teaching and learning strategies, which involved m-learning, face-to-face lectures and the university learning management system, SPIN. A questionnaire was used to collect the data at the end of the activities. Data was analyzed and findings were then reported in this paper.

1.1 Mobile Learning

According to Moseley & Higgins (1999), mobile devices can be more easily integrated across the curriculum than desktops. This is possible since many students already have mobile devices and wireless mobile devices do not need extensive infrastructure as desktop computers. The mobility enabled by these devices can also foster a greater feeling of work ownership by students. Additional research shows gains in students' motivation in their studies. Time needs to be allowed to ensure adequate familiarization with the new mobile devices. Technical staff must be available for helping. The pedagogical approaches and goals must be clear as in traditional teaching (British Educational Communications Technology Agency, 2004).

M-learning has been a subject of interest to researchers for the past one decade, and many research findings indicate that m-learning is an effective tool for strengthening learning strategies as well as m-learning learners can utilize wireless network and mobile learning device to get convenience, expediency and immediacy of mobile learning in appropriate time and accessing appropriate learning content (Su et al. 2004). The last ten years have also seen a revolution in communications and computing technology, with the installation of digital cellular phone net works, and development of mobile computers and digital cameras. These three technologies are now converging, into personal digital assistants that enable learners to access internet resources and run experiments in the field, store and manage everyday events as images and sounds, and communicate and share the material with fellow learners throughout the worlds. According to Sharples et al.(2000), there is a natural alliance between learning as a contextual activity and the new personal technology, so that it is becoming feasible to equip learners with powerful tools to support learning anytime, anywhere. The fact that mobile phone could be used on the move, e.g. in a bus or train anytime, anywhere to make learning environment lifelong. Prensky in Tsi(2005) indicates that children are growing up with wireless mobile technology with positive outcomes in modern society and some technologically-advanced countries start to conduct wireless mobile technology in their educational institutions.

According to Sharples (2000), formal education cannot provide people with all the knowledge and skills they need to prosper throughout a lifetime. Therefore, people need continually to enhance their abilities, in order to address immediate problems and participate in a process of continuing academic and professional development. Ting (2005), in his research mentions that fundamental belief of mobile learning is not to convert all PC-based learning content into a mobile format, but to consider how the mobile devices can be used to strengthen and harmonize overall learning strategy.

M-learning is contributing in various way including voice communication, e-mail interaction, short message service etc. Voice communication provides negotiation between facilitators and learners for support and cooperative purposes. To access the learning portal in the internet, the learning management system provides appreciatory content to support the continuity of learning activities. The facilitators can send reminders and alerts to their learners through SMS (Short Message Service) as a powerful way and help to keep them on the proper learning way. The SMS can also be sent as a daily message to learners as a daily amount of learning.

2. FOCUS OF THE STUDY

The focus of this study is to investigate the students' acceptance on the mobile content developed for the Research Methodology course developed. This may link heavily to their daily operational use of mobile phones. In general, there are three dimensions that are critically affecting the success of m-Learning, which are location independence, meaningful content and time independence (Rosenberg 2001). Among the three dimensions, mobile phones have greater advantages in term of "location independence". Mobile phones make it possible to gather and record information nearly everywhere. They have the highest mobility inside or outside classrooms. The coverage of mobile phones allows lecturers to engage in activities requiring ubiquitous tools. With respect to the dimension of "time independence", mobile phones can also be used in asynchronous and synchronous learning. SMS and forum messages can be retrieved and sent to support asynchronous learning. The dimension of "meaningful content" is the most critical one. Without quality content, m-Learning will be meaningless. There are many factors adversely affecting the delivery of quality content using mobile phones. Slow processing speed, limited bandwidth, small form-factor, limited memory and one-finger operation are some of them. Through this research, the authors would like to investigate the students' acceptance of the mobile content developed for the Research Methodology course for the post graduate students. The m-learning environment was implemented in the blended teaching and learning mode. The results are hoped to provide output for the future planning of the reconstruction of the post-graduate teaching and learning strategies.

Since a mobile phone is nothing more than a limited but featured computer, the limitations of these devices must be recognized. Furthermore, the researcher would like to develop what they can do best. In this study, the author has developed the mobile content for the Research Methodology course using blended teaching and learning strategy. The activities involved face-to-face lectures, online forums, SMS's, online quizzes and activities involved in the university learning management system, SPIN. These activities covered the major directions in m-Learning for the whole one semester (14 weeks). One-off experiment was performed and a questionnaire was used to collect data.

2.1 Methodology

This research involved 2-phase study. Phase 1 is the Design and Development of mobile content for the Research Methodology course and Phase 2 is the Evaluation of the mobile content developed. In this research, Simulators developed to execute in real mobile phones were used for this study (Openwave, 2006). There are three reasons for this approach. Firstly, the chosen software has been implemented in a number of real phone models. It behaves like a real phone. Secondly, many students may not have mobile phones with advanced features to support WAP 2.0 (Wapforum, 2006). Some students may still have text based mobile phones! To support the experiment of this research or any m-Learning application in general, a WAP gateway connected to a Web server is needed. In this study, the author has developed the mobile content for the Research Methodology course using blended teaching and learning strategy. The activities involved face-to-face lectures, online forum, sms's, online quizzes and activities involved in the university learning management system, SPIN. These activities covered the major directions in m-Learning for the whole one semester (14 weeks). Figure 1 to Figure 4 show the interfaces of the Registration Menu, Content and the Forum, respectively. The website can be accessed through the following URL: www.ukmmobile.mobi.

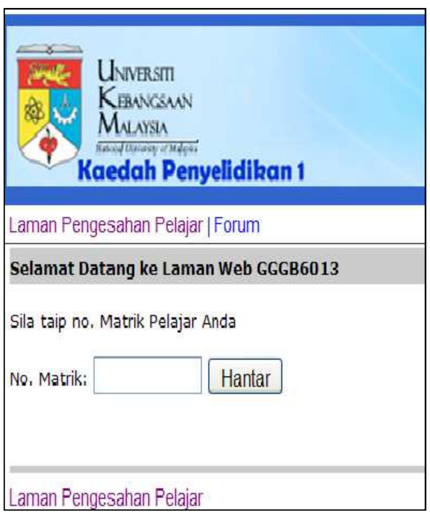


Figure 1: Registration Menu of the Research Methodology Course Mobile Content

Figure 2: Content Menu of the Research Methodology Course Mobile Content

Figure 3: Mobile Forum of the Research Methodology Course Mobile Content

The second data set was for the questionnaire. The questions were categorized as follows:

- Demography– to establish the background of the students.
- Usage and practice – to find out the types of communication used using the mobile phones.
- Acceptance of mobile phones in teaching and learning – to find out how the students feel about the use of mobile phones for teaching and learning of the Research Methodology Course.

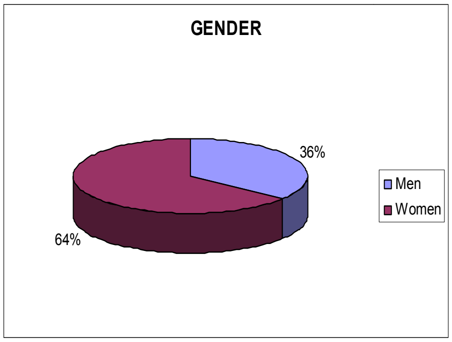
2.2 Results

A total of one hundred and twenty post-graduate students from the Faculty of Education, Universiti Kebangsaan Malaysia completed the mobile learning activities for the Research Methodology course for the whole semester (14 weeks). Blended teaching and learning strategy was used for this study.

The data obtained from the questionnaire were keyed into the database for analysis.

2.3 Demography

Figure 4 to Figure 6 provide demographic overview of the respondents with respect to gender, number of hand phones owned and hand phone ability to access the Internet.



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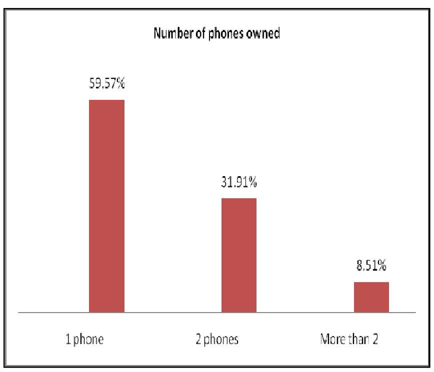

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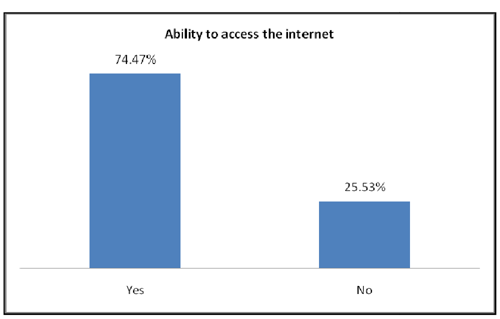


net

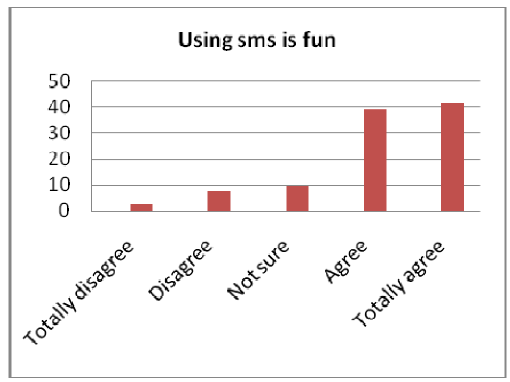
a. The distribution of male and female respondents reflects the typical composition of any education programme in the higher education institutions in Malaysia.

b. The output reveals that, 59.57% of the students own 1 hand phone, 31.91% own 2 hand phones and 8.51% own more than 2 hand phones.

c. 74.47% of the students have the hand phones which are able to access the Internet.

2.4 Usage and Practice

Figure 7 reveal how the respondents use the SMS feature. More than 40% thinks that using SMS is fun. Figure 8 and Figure 9 reveal about the communication on academic matters over the hand phones. 56.1% of the respondents agree on communicating academic matters over the hand phones. 43.9% of the respondent totally agrees to communicate with their lecturers using the hand phones.



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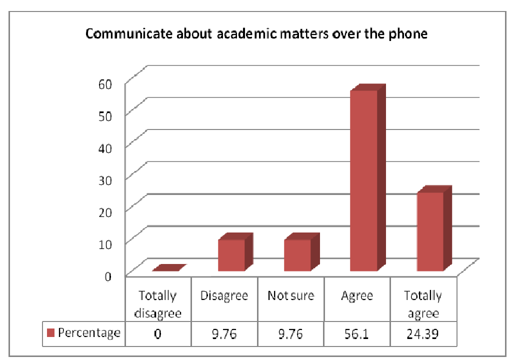

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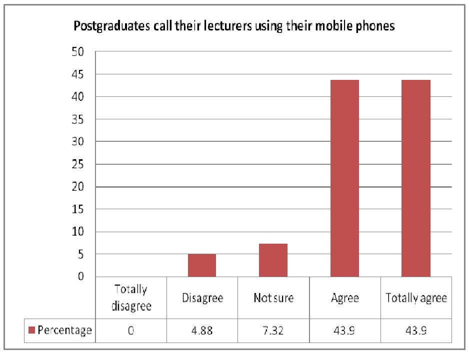

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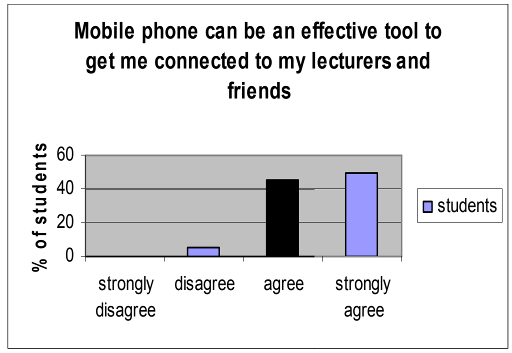

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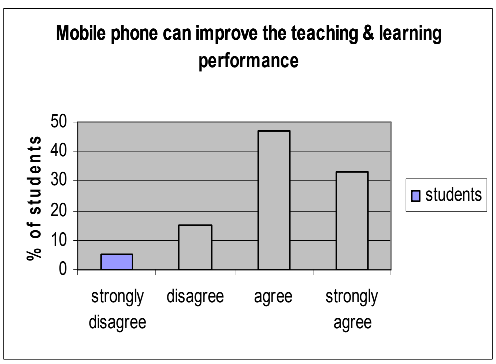
2.5 Acceptance of Mobile Phones for the Teaching and Learning of Research Methodology Course

This section provides answers to the focus of this research. Respondents were asked to express their views on using mobile phones for the teaching and learning of the Research Methodology course. After they have experienced the mobile learning activities using blended teaching and learning strategy, respondents provide their opinions (Figure 10 to Figure 16).



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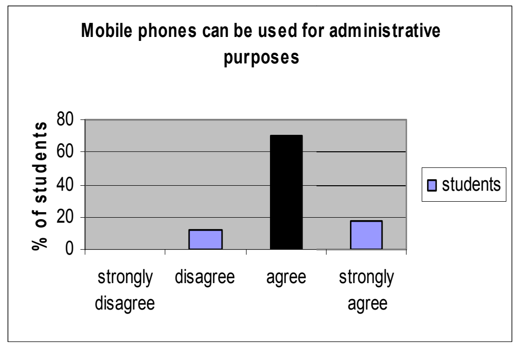

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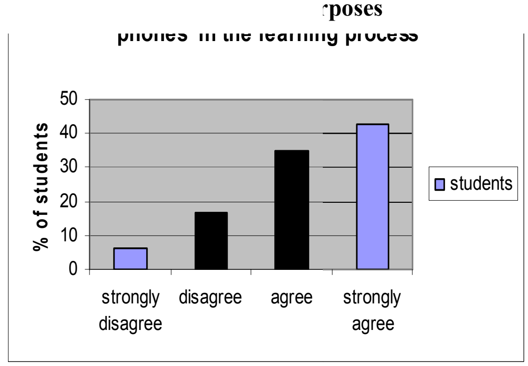

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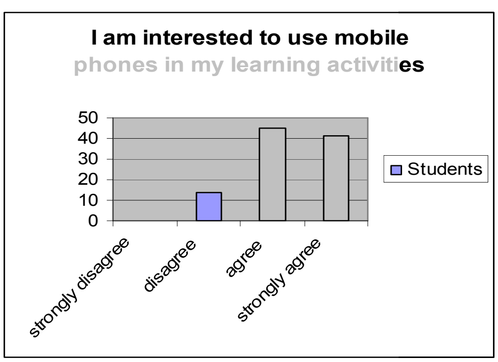

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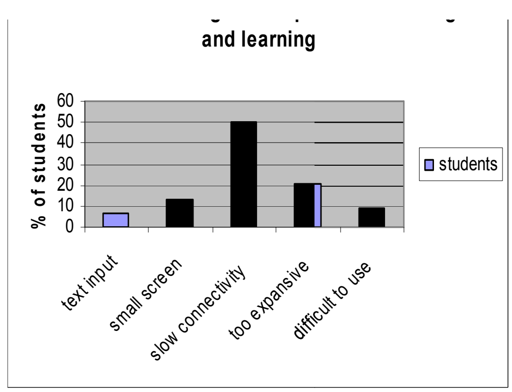

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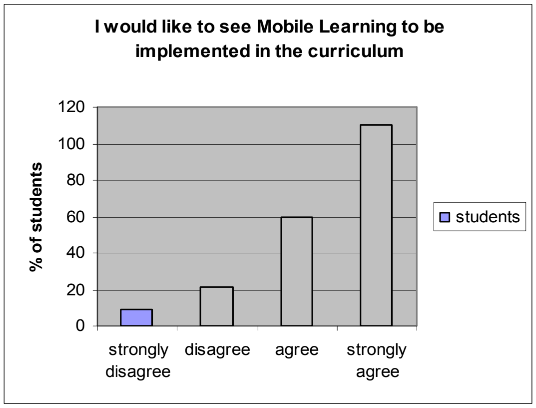

Figure 16: Mobile learning to be implemented in the curriculum

This study shows that the majority of the respondents accepted the use of mobile phones for teaching and learning in general. They found the inhibiting factors are slow connectivity (50.5%), too expansive (20.5%), small screen (13.5%), difficult to use (9%) and text input problem (6.5%).

They somewhat agreed that mobile phones can improve the teaching and learning performance (47% + 33% = 80%). Their curiosity on using mobile phones for teaching and learning is high (45% + 41% = 86%). The respondents are confident that mobile phones can be effective tools to them to get connected to their lecturers and friends. They would like to use mobile phones for administrative purposes (70% + 18% 88%). They were somewhat interested to see "m-Learning" be part of their curriculum.

3. CONCLUSION

The focus of this study is to investigate the students' acceptance on the mobile content developed for the Research Methodology course developed. The experiment was generally well-received by the students. They found that it is fun to participate in the exercise. The findings of this study reveal that the students agreed that mobile phones can be used for teaching and learning and the mobile content developed for the Research Methodology course benefit them. Majority of the students are very liberal and interested to use mobile phones for teaching and learning. With the background as adult learners, SMS messaging is a popular way to communicate. Although the sample size is small and the findings may not be reliable, this study provides the researcher with the preliminary data to carry out more discriminating experiments on mobile content development for post graduate courses. From the study, it can also be revealed that m-Learning activities are great ways to motivate the adult learners and foster interaction among them. This is not only applicable to the field of m-Learning, but also a general androgogical technique in teaching and learning.

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Making education work: Mobile technologies for work-based and vocational learning

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Abstract
The Learning and Skills Council (LSC, now the Skills Funding Agency, www.skillsfundingagency.com), together with participating English further education colleges, schools and specialist colleges have invested over £16 million over the past three years (2007-2010) in the MoLeNET (The Mobile Learning NETwork, www.molenet.org.uk) initiative. Capital funding contributed by the LSC has enabled participating institutions to purchase mobile devices and infrastructure technology. Whilst the college/school contributions have funded LSN's MoLeNET Support and Evaluation Programme which was designed to ensure successful introduction, and subsequent embedding, of mobile technologies into teaching and learning and to evaluate the impact on teaching and learning. Support provided includes project management, technical training, staff development, development of mobile pedagogy, provision of tools, materials and systems, and research and evaluation. MoLeNET projects have procured a range of handheld technologies and have used these to support teachers and learners in various subject areas and locations both inside and outside of the college/school. This paper focuses specifically on the ways in which projects have used mobile devices to support vocational and work-based learners to improve access to resources and materials and to streamline and personalise the assessment process. Research findings indicate that mobile technologies have been successfully used to accomplish these aims in numerous projects, a few examples of which are discussed.

Keywords
Mobile learning, work-based, vocational, assessment, evidence collection, resources, access

1. INTRODUCTION
MoLeNET (The Mobile Learning NETwork, www.molenet.org.uk) is an initiative designed and managed by LSN (www.lsnlearning.org.uk) with substantial capital funding provided by the Learning and Skills Council (LSC, now the Skills Funding Agency, www.skillsfundingagency.com). During the three academic years 2007/08, 2008/09 and 2009/10 the LSC, together with participating English further education colleges, schools and specialist colleges have invested over £16 million to introduce mobile learning and to investigate the impact on teaching and learning.

Over the three years 104 projects have procured a wide range of mobile devices plus infrastructure technology including servers and wireless networks. Devices purchased have included mobile phones, smartphones (including iPhones), PDAs, MP3/MP4 players (e.g. iPods), iPod Touches, other media players, handheld games devices (i.e. Sony PSP, Nintendo DS), digital cameras, Ultra Mobile PCs (UMPCs), mini notebooks or Netbooks , handheld GPS devices, handheld voting systems and specialist or assistive handheld technologies used in science labs, engineering workshops or for environmental or agricultural study, or for learners with specific learning difficulties and/or disabilities.

The programme has been organised using a shared cost funding model, with participating institutions contributing an amount equivalent to 20% of the capital funding provided by the LSC to pay for the LSN Support and Evaluation Programme. The programme provides support in the areas of project management, technical training, staff development, development of mobile pedagogy, provision of knowledge sharing and peer-to-peer support tools and systems, and research and evaluation. Specialist mentors are assigned to MoLeNET projects to provide key advice and training in order that those involved are able to make the most of the technologies purchased and use them appropriately and effectively in teaching and learning contexts. A MoLeNET virtual learning environment (the MoLeNET Moodle: www.molenetprojects.org.uk) enables practitioners and staff at participating colleges and schools to discuss ideas and access key training materials and documentation to support their project implementation and evaluation.

Several tools and systems have been developed by LSN during the course of the MoLeNET programme and are publically available, with the aim of contributing to sustainable development of mobile learning for educational institutions in England and beyond. These systems include MoLeSHARE (www.moleshare.org.uk) - an ever expanding bank of mobile learning files and materials such as lesson plans, case studies and resources; MoLeTV (www.moletv.org.uk) - a system for sharing, converting, streaming and downloading video resources including learning materials for many subject areas and feedback from teachers, learners and management about their experiences of mobile learning.
A major strand of the support and evaluation programme is research and evaluation. This strand, delivered by LSN's Technology Enhanced Learning Research Centre, includes research by LSN researchers and statisticians as well as training and support of practitioner researchers based in participating

institutions who carry out action research and data collection throughout their project.

MoLeNET is now in its third year, with a total of more than 30,000 learners and 6000 teaching staff involved to date. The projects have involved a wide variety of learners and learning contexts with learners from different backgrounds studying at different levels, (e.g. GCSE and A level, ESOL [English as a second or other language], mature students, ex-NEETs [young people not in education, employment or training], apprentices, part time students, learners with learning difficulties and/or disabilities) studying academic and vocational courses using mobile technologies in different places, at different times and in different ways.

This paper focuses on those learners who have used mobile technologies to support their vocational or work-based/place learning. Through three years of MoLeNET, the use of devices in work-based and vocational learning settings has been prominent. For example, in 2007/08, of the 6,412 learners for whom projects reported a subject area, over 40% (2,668 learners) were reported to be studying a vocational subject. In the second phase of MoLeNET, 2008/09, projects were asked to indicate which priorities they had addressed. Of the twenty-nine that responded, thirteen identified work-based learning as a priority, four indicated apprentices, six land-based subjects, five Train to Gain, and ten identified teacher training as a priority of their project. In the third year of MoLeNET projects bidding for funding were asked to focus mainly on employment and employability, sustainability solutions or holistic change. Of the twenty two successful projects almost three quarters identified employment and employability as their key area of focus.

This paper presents research evidence from projects involved in the first two years of MoLeNET focusing on the use of mobile technologies to enhance work-based and vocational learning provision. Further details about the overall impact of MoLeNET phase one can be found in Attewell, Savill-Smith and Douch (2009); and phase two in Attewell, Savill-Smith, Douch and Parker (2010). For a more detailed report of MoLeNET phase one and two findings and best practice relating specifically to vocational and work-based learners and learning contexts see Douch, Savill-Smith, Parker and Attewell (2010).

2. BACKGROUND AND CONTEXT

The projects that have informed the research for this paper have used mobile devices for teaching and learning in a large variety of contexts and settings. The technologies have been used in education and skills development courses where the setting for the delivery of the course is a professional environment. These environments include for example hair-dressing salons, a laundry and restaurants. Some projects included learners who balance education and employment by accessing learning opportunities while they are at work with the support of their employer and their college tutor. Other projects involved learners working to acquire qualifications with the evidence of skills and learning required for assessment being gathered in their workplace.

Vocational learners involved in the research for this paper were enrolled predominantly in full-time training courses often set in more than one location, with part of their course delivered in a course-specific environment such as a workshop or training kitchen, and part in the classroom. Many of these courses include a key or basic skills element presenting additional challenges to teachers and learners.

Within education, work-based and vocational learning presents several unique challenges which may explain the enthusiasm with which institutions involved in MoLeNET have engaged with mobile technologies in these areas. This paper focuses on two issues addressed by projects in these areas: the creation of, and access to, learning resources and the collection of evidence for assessment. However, MoLeNET projects have addressed other areas of work-based and vocational learning provision as well, including the use of devices to support key and basic skills development and the introduction of mobile devices into the process of teacher training.

2.1. Accessing and Creating Resources

A common issue for work-based learners is a lack of sufficient direct interaction with teaching staff, especially as learners may be based in geographically remote locations. Flexibility of access to learning opportunities is considered greatly desirable in work-based learning particularly because learners often include more mature people, in addition to 16-19 year old learners, who may have more family and work related pressures and demands on their time.

The work-based learning context can place restrictions on the type and volume of resources and learning opportunities that tutors are able to provide and that learners are able to access. It is often impractical for learners to carry text books or exercise books with them in their workplace. The availability of computers and access to the internet is also often restricted or unavailable. This severely restricts the time work-based learners can devote to course-related learning. The introduction of mobile devices gives tutors the opportunity to deliver directly to learners content-rich and varied resources, such as audio and video podcasts, PowerPoint presentations and quizzes, and even whole e-books. When wireless networks or mobile data contracts are available the mobile devices can also be used to access the internet and college virtual learning environments.

Furthermore, limited opportunities for communication have a negative impact on the effectiveness of the relationship between the teacher and the learner. Also work-based learners often miss the valuable benefits of peer-to-peer collaboration and discussion. It was felt by several projects that mobile technologies represented an exciting opportunity to overcome these barriers to learning.

2.2. Evidence Collection and Assessment

The nature of the skills developed during vocational courses or apprenticeships makes evidence collection and assessment a challenge. For vocational learners in work environments the process of producing evidence is often time consuming, difficult and stressful. This is the case for all learners, but particularly those with learning difficulties and/or disabilities, or with low literacy skills. The evidencing process often involves extensive written work as well as photographing the learner demonstrating their skills and observations by assessors. E-portfolio systems have increasingly been introduced, but these are often not accessible in the location where most learning and assessment takes place, and require completion at a later date. As well as adding an extra layer of complication for the learner, this also potentially reduces feedback opportunities. Learners may have to take time away from their work responsibilities to complete assessment requirements, sometimes travelling to assessment centres and away from the environment in which they are comfortable, where they have learned and practised their skills.

Many projects reported that the introduction of mobile devices had the potential to revolutionise the process of evidence collection and assessment for vocational learners. Projects envisaged potential benefits in terms of efficiency for the learner and the employer, reductions in the stress and difficulty of the assessment process, and significant improvements in the quality of the evidence produced.

3. RESEARCH APPROACH

Research is an integral and important aspect of the MoLeNET programme, which aims to investigate

1. How colleges and consortia partners use mobile learning to improve teaching and learning
2. The impact of mobile learning on learners, teachers and institutions
3. Whether mobile learning can help improve retention, progression and achievement

MoLeNET projects are very diverse in their nature, involving learners from a variety of subject areas, working at different levels, using a multitude of mobile devices in various ways to support their learning experience. In such a diverse programme as this it would be very difficult and perhaps ineffective to solely conduct outsider, top down research. Therefore the design of the programme combines programme level research led by LSN researchers, including statistical analysis of learner retention and achievement data, with practitioner led action research.

Practitioner led action research is appropriate ‘whenever specific knowledge is required for a specific problem in a specific situation; or when a new approach is to be grafted onto an existing system’ (Cohen & Manion, 1995, p194) and is ‘concerned with social practice, aimed towards improvement, a cyclical process, pursued by systematic enquiry, a reflective process, participative and determined by the practitioners’ (Kember, 2000, p24). LSN’s Technology Enhanced Learning Research Centre have developed their own definition of practitioner led action research as follows: ‘A research approach with the fundamental aim to help professionals (teachers, managers) to improve practice and to understand change processes. Using a cyclical process to diagnose issues for investigation, plan research strategies, implement, review and reflect upon findings.’

In addition to being able to address the diversity of the MoLeNET projects it was also hoped that practitioner led action research would encourage change and promote sustainability for the following reasons:

- The research is relevant to the individual context in which it takes place, therefore the findings are meaningful and enlightening for practitioners working in these contexts.
- Action research is focused on improving practice and is cyclical in that it involves cycles of planning, acting, observing and reflecting, which can promote continuous improvements in response to the research rather than one off change following a post intervention evaluation.
- Action research may be particularly appropriate in this context as Somekh (2000) identify its suitability for studies into the usage of information and communication technologies in education.

Within each MoLeNET project not only is a Project Manager assigned to manage the procurement and day to day running of the project, but also a Lead Practitioner Researcher (LPR), (in most cases a member of the teaching or IT staff) is appointed to manage the action research. LSN provide training and support to the LPRs to enable them to conduct the research within their individual projects, at the end of which they submit a report of their findings to LSN. Very positive feedback regarding the action research process has been received. The majority of LPRs have stated that they feel it has helped to promote the project and the potential of mobile teaching and learning and also to continuously drive the project forward to affect change. They have been able to gain feedback from a wider audience than would have been possible without the research and have been able to use this to share good practice and inform strategies and policies to encourage sustainability of mobile teaching and learning.

Nevertheless, large scale practitioner led action research does produce a number of challenges including:

- The outputs can be difficult to quantify or generalise as they are often context specific and stringent experimental methods such as control groups are not often used as they are not appropriate in an educational setting that promotes equality of opportunity.
- Extensive training and support is required in order that practitioners work in a rigorous research focused manor.
- Lead Practitioner Researchers must dedicate a great deal of time and effort to collecting, analysing and disseminating information, whilst continuing their normal work responsibilities.
- External and uncontrollable factors such as staff changes and college/school inspections can influence the research.

3.1. Research methods

Each Lead Practitioner received a site visit by LSN to develop two research questions that would address some of the aims of their MoLeNET project. The research questions vary from project to project but often explore areas of the learner experience such as accessibility, engagement with learning, communication, assessment processes, attendance, achievement, etc. As well as focusing on specific groups of learners with specific requirements such as learners with learning difficulties and/or difficulties, work based learners, ESOL learners or learners with literacy or numeracy needs. In each case informed consent was collected from all participants prior to engaging with the research.

For each question, LSN staff helped the LPRs to develop an action plan detailing the evidence required to answer the research questions; the research methods to be used; when, with whom, and by whom they would be implemented; and when and by whom the analysis would be carried out. LSN provided face-to-face and online training in a range of research methods to support the Lead Practitioner Researchers in selecting the most appropriate research methods for their research questions, designing valid and reliable research tools, and effectively analysing and interpreting data collected. In most cases the LPRs chose three or four research methods to answer each of their research questions, and gathered data from both teaching staff and learners, and, where appropriate, managers, IT staff, governors, assessors, employers and/or parents. LPRs were encouraged to ensure that analysis took place on a continuous basis, rather than simply at the end of the project, so that emerging findings could be shared with project staff and therefore inform practice. The following provides a brief overview and evaluation (from the perspective of the Lead Practitioner Researchers) of the research methods used during the action research process:

1. Questionnaires: Most LPRs used questionnaires and found them helpful in comparing pre and post project opinions and attitudes. Some were administered as paper questionnaires and others using online software or VLE feedback forms, the latter two providing some degree of automatic analysis. A range of mainly quantitative data was collected via questionnaires, often using Likert scales to record opinion change. However, although most LPRs found questionnaires quick to implement and analyse, many were disappointed with the response rate (particularly for post project questionnaires) and some found that the questions they had asked did not really provide them with all of the data they intended to collect using the tool. Mixed success was experienced where open ended text responses were required.
2. Interviews and/or focus groups: Focus groups in particular provided a wealth of detailed and rich evidence of attitudes, experiences and reasons for various opinions. Interviews were used in some cases with teachers or where it was difficult to gather a group of participants together for a focus group (e.g. with work-based learners), however focus groups were considered to provide a less formal atmosphere where participants felt more confident in expressing their views and enjoyed sharing experiences and ideas. In most cases the focus groups were recorded using a digital voice recorder, and key messages and quotes were extracted during the analysis stage (full transcription of the recordings was impossible in most cases because of time restrictions). In some instances LPRs used findings from questionnaires to inform focus group schedules, and where focus groups could be carried out at a number of stages throughout the project this not only provided a rich source of evidence but also an opportunity to assess progress and issues and to change the course of the project as necessary.
3. Blogs, forums, Wikis, video/audio diaries: Many of the projects set up forums, blogs or Wikis, or encouraged the use of video or audio recording, for teachers and/or learners to record their comments and reflections about the project. Lead Practitioner Researchers used this information to gather evidence of reactions to teaching and learning experiences and to inform project progress. In some cases these areas were used very well, however in others uptake was slow and participants preferred to keep notes or share feedback via email or face-to-face.
4. Individual learner data: Where available, LPRs collected data relating to grades, attendance patterns, homework submissions, timeliness of completions, lateness etc. and compared data with previous years or with similar cohorts without access to mobile technologies. Although in some cases this data provided some impressive results, LPRs found it difficult to ensure comparison

groups were valid and often had to rely on predicted results due to the time of the year that the data was collected.

5. Observations: A small number of projects used lesson observations to gather evidence relating to how technologies were being used for teaching and learning and to measure learner enthusiasm and participation. Some teachers felt that these observations were a little intimidating, especially during the early stages of the project, though where LPRs explained that the observations were not to assess individual performance, this helped to alleviate these concerns.
6. Web statistics: Where projects set up dedicated areas in their virtual learning environments some LPRs obtained statistics relating to access times, number of material downloaded etc. to support other evidence collected.
7. Documentary evidence: Policies, meeting minutes, lesson plans and schemes of work provided useful evidence of the extent of change and the impact of the project at the institution level.

To find out more about the action research findings from MoLeNET phase one see Attewell et al (2009) (available at www.molenet.org.uk/pubs). For phase two of MoLeNET see Attewell et al (2010).

4. RESEARCH FINDINGS

Findings from the action research indicate that mobile technologies have a very important role to play in improving teaching and learning in work-based and vocational settings. The findings can be summarised within the two key areas discussed above.

4.1. Accessing and Creating Resources

Mobile devices have enabled many learners to access both online and offline electronic resources remotely, whenever and wherever is convenient for them. This has meant learners who previously had difficulties accessing resources and learning materials due to minimal or no access to technology (e.g. in the workplace, a salon or a workshop) have been able to use resources that have been uploaded to individual devices or the institution's virtual learning environment (VLE), or materials readily available through websites. Exeter College reported that 'Learners commented that they liked the flexibility that the devices gave them, for instance being able to take devices to work and being able to complete work outside the college environment.' These resources and materials may be in the form of slide shows, quizzes, videos, podcasts etc and have often been created by the teaching staff or by the learners themselves. For example, in several projects teaching staff have recorded themselves performing specific tasks that the learner can then use as an instructional tool or as revision material. The benefit here is that the learner can replay the recording as often as required and can pause and rewind where necessary, thus ensuring that important points are not missed and learners are able to work at their own pace. Provision of such resources has therefore enabled teaching staff to provide more differentiated and personalised resources for learners of different levels of ability or requirements, and with varying learning styles. Furthermore, some learners have recorded video and photographic evidence which has then been used as teaching and learning stimuli or as a resource for other learners.

Projects
engagement as a result of improvements in learner have reported improved provision of access to
multimedia
channels through email/text and Skype etc., with learners resources and better communication
feeling that their learning experience has become more enjoyable and personalised. Work-based learners have reported feeling more a part of the college and better supported.
improvements in learner retention and achievement. The learners have also been reports of

4.2. Evidence Collection and Assessment

Using mobile devices to gather evidence for assessment purposes has proven extremely popular and effective in many MoLeNET projects. Learners have used devices with a camera function to record themselves completing a task as evidence of progress and achievement. This recording is then submitted to the tutor or assessor or forms part of the learner's portfolio of work and can be edited to include notes and reflections in written or voiceover format. This mode of evidence collection has benefited many learners for whom literacy is a barrier and therefore writing reports is difficult and disengaging. Learners have been able to produce a wealth of high quality evidence using mobile technologies and have further benefited from being able to collect evidence at a time that is convenient for them rather than having to wait for an assessor to be present. This also reduces the pressure that many learners feel when being observed. The programme manager for Cornwall College's NVQ in horse care reported 'A bright student wishing to complete their level 2 quickly in order to progress to level 3 might be able to use this way of collecting evidence to fast track their achievement.'

Furthermore, some learners have been able to collate and manage their evidence in an electronic portfolio, thus enabling them to store all of their evidence in one safe place that is accessible remotely. One learner at Leeds College of Building commented 'The Netbook has helped me to record my evidence from the site and carry out my homework. I do not have to carry paper documents with me and re-type them in.' Also, by submitting evidence in this way, teaching staff and assessors are then also able to provide feedback much more quickly, thus enabling mistakes and learning points to be identified earlier.

Additionally, recordings of learners carrying out tasks have been successfully used to encourage reflection and self and peer assessment. This can be facilitated using mobile devices with screens which provide a good viewing experience, such as the Sony PSP, or by linking to a large screen. Learners have been able to critically review performances and learn from each other's feedback.

5. KEY OUTCOMES

As a result of the improvements to the learning experience as discussed above, a number of key outcomes have been measured, observed and fed back as part of the action research process. Key messages from this data indicate that in vocational and work-based learning contexts, mobile technologies can:

- Improve engagement with learning by making learning more flexible, relevant, interactive and personalised.
- Provide better access to learning opportunities thus enabling learners to develop their knowledge and skills at a time, place and pace that is convenient to them.
- Provide opportunities for self and peer assessment, enabling learners to better recognise where they need to improve and take ownership of their learning.
- Enable evidence of learning to be collected and submitted more efficiently and effectively, often resulting in a better quality and volume of evidence, and in some cases faster course completion.
- Improve communication and feedback mechanisms, thus ensuring that the learner is better supported and feels more a part of the college community.
- Improve learner achievement.

Although it has been difficult for some MoLeNET projects, as there may be insufficient evidence within the timescale of the project or a lack of control or comparison cohorts, others have been able to evidence improvements in learner achievement. For example, Ashton Sixth Form College found that 100% of their level 3 public services students who used mobile devices to support them on a specific unit of their course passed this unit compared to 94% of the control group who did not use the devices. Capel Manor College reported an increase in predicted achievement in level 2 and 3 learners studying in the school of arboriculture and countryside, explaining 'In almost all subjects taking part in the project we have not only seen major increases in the pass/fail ratio, but also an increase in those students that are achieving higher end grades (merits and distinctions). More pass-level students are moving up to achieve at merit level, and more merit-level students are set to achieve at distinction level.' Redbridge College found that achievement rates of vocational learners involved with MoLeNET revealed up to seven percentage points improvement compared to those on the same course but not involved with MoLeNET.

6. GOOD PRACTICE CASE STUDIES

6.1. Kingston College: Kingston Access to Podcast Technology for Interactive Virtual Assessment and Teacher Education

6.1.1. Introduction and overview

In this case study, the sports and leisure faculty built on previous mobile learning work to create video podcasts to which hairdressing, beauty and sports learners could subscribe. Demonstrations were recorded with the specific aims to reduce consumption of expensive resources required each time a particular activity is demonstrated and to enable all learners to be able to clearly observe specific techniques and procedures at their own pace. Tutors recorded a variety of content ranging from customer service skills, hairdressing techniques and exercise routines, then edited the videos, ensured they were in the correct format and uploaded them to a podcast site. The learners subscribed to the RSS feed generated by the site enabling content to be automatically delivered to the student's iPod device, allowing for access at any time or place.

6.1.2. Research findings

Many of the learners showed improvements in their progress and achievements as a result of being able to access these high quality learning resources and being able to use video rather than text based materials. One learner explained 'The one [podcast] of the test was particularly useful… I passed I got my merit criteria straight away, so it was really helpful.' And another reported 'We had a test on skin disorders and [teacher] kindly made us a video so we can memorise it effectively.' The learners were able to review material as often and in as much detail as they wished and benefited from being able to fill previously so called 'dead time', e.g. whilst in transit, with study and revision . The tutors commented that the resources were a good investment as they could be used in subsequent years without the requirement for an additional time investment.

Recordings of the learners themselves were also created and the podcasts were used for assessment and reflection purposes. Additionally, learners used the diary and note taking functions on the device to support their studies and were able to correspond via email with greater ease by connecting to the college network through their individual devices rather than being restricted to desktop computers.

6.1.3. Lessons learned

Initial challenges were faced with installation of iTunes on the college network so these issues had to be overcome before the project could take off. Also not all students were skilled and confident with using the iPods, so time and support was required to assist these students in subscribing to the podcasts.

6.1.4. Future plans

Following this successful initiative in 2008/9, Kingston College were planning on rolling out the iPods to new courses and developing training opportunities for teaching staff to explore the pedagogy of podcasting.

6.2. Leeds College of Building: Heating and Ventilating Mobile Learning

6.2.1. Introduction and overview

Netbooks were purchased for level 2 NVQ heating and ventilation engineers to enable them to collect evidence of their progress and achievements in the workplace and to be able to continue to study their trade at a convenient place and time when not in the college. Learning resources in the form of materials, practice exam questions and set tasks were collated within a webpage to enable learners to easily access them through the web browser. Furthermore, each Netbook was preloaded with resources.

6.2.2. Research findings

Learners' achievements could be recorded directly onto the Netbooks using the built in camera and a microphone connected via the USB port. Images recorded using learners' own mobile phones could also be Bluetoothed to their Netbook for inclusion in their portfolio of evidence for assessment. One tutor explains how they supported the learners in making the most of this opportunity 'I was able to set-up a simple e-portfolio for each learner with direct hyperlinks to electronically collected images, audio recordings (taken on site by a microphone linked directly to the USB port on the Netbook), assessment evidence and assignments for each learner using a Word document. The reduction in the collection of paper based evidence has now reduced the need for printing out copies and helping to save on paper and printing costs.'

The learners were also able to conduct research, use the preloaded resources to support their learning and carry out tasks set by their tutor at a time that was convenient for them, without having to wait for the family computer to become available. In addition, when the learners attended college for the college based sessions they were also able to use the Netbooks in the classroom to access the internet for research purposes and to write up notes and requirements.

A work-based learning provider involved in the project explained how the mobile devices improved both the learning experience and efficiency of evidence collection 'Work on the learners' portfolio is completed in a more timely manner and enables all learners access to a mobile device away from college. I feel it increases the learners' ownership of their work and particularly their portfolio. Some learners told me how the Netbook aided them during revision periods.'

6.2.3. Lessons learned

There was some initial time and manpower required at the beginning of the project whilst the Netbooks were being prepared and the necessary software and resources were being installed and set up. Plus there was also some requirement to continue to monitor the devices when in use to ensure no viruses had been picked up through the downloading of content.

6.2.4. Future plans

It was planned that this cohort would continue to use the devices in 2009/2010 with a full year's worth of learning resources available to them so that further research into the impact of mobile teaching and learning could be conducted. Using learners' own mobile phones worked particularly well in this project as there is no cost incurred when transferring files through Bluetooth, therefore helping to make this initiative sustainable in the future. Members of the Senior Management team at Leeds College of Building are particularly impressed with the potential of mobile teaching and learning for work-based learners reporting that 'This has been a big plus in helping us to move forward with the improvement of mobility for candidates accessing work based e-learning. We have flexible delivery in respect of everything the learner needs to study and evidence collection built into the mobile device. The flexibility offers work-based collection of evidence, revision and phase tests with a home revision pack. We hope this will ultimately integrate into our e-portfolio requirements.'

6.3. Accrington and Rossendale College: Evidence for Work-based Learning

6.3.1. Introduction and overview

This case study explores the experience of one learner enrolled on the NVQ level 2 customer service course at Accrington and Rossendale College. This particular learner was a single mother with a job at a local DIY shop, hoping to gain a formal qualification in customer service. The learner in this case study had a specific learning difficulty so required additional support, and interestingly the assessor also had dyslexia so there was a real opportunity available to investigate ways to improve the process of collecting evidence of progress and assessment processes. Other key aims of the intervention were to examine ways in which assessment could be carried out in line with the learner's working hours and without obstructing customers in the workplace.

The learner used a Netbook to access materials outside of college and in the workplace and was also able to contact her tutor via Skype and work on live documents together by sharing desktops. This meant that the amount of time that the learner needed to come into college was reduced. The learner and assessor also worked together using a digital voice recorder to record discussions about observations that had taken place and to record evidence of knowledge, as opposed to writing reports. Dragon Speaking software was then used to convert the audio material into text. This voice to text software also enabled the assessor to record assessment feedback for the learner, which resulted in more effective and detailed feedback as dyslexia was no longer an issue using this technique.

Another tool which was also of great benefit to the assessment process was Text Tools. The learner could text statements or questions to the tutor, which could then be answered or printed out and used as evidence of understanding. This toll was easy and convenient to use as it was something that the learner was already familiar with and wasn't time or place dependent.

6.3.2. Research findings

Using these mobile technologies helped to streamline and personalise the assessment process, meaning that less time was required for assessment in the workplace and that the assessor and the learner could work together in a flexible, efficient and effective way. The evidence collection process felt more natural for the learner and the issues usually encountered by both the learner and assessor due to their specific learning difficulties were no longer a barrier. The Netbook helped to enable the learner to keep in touch with her tutor and to access resources and support without needing to go into college, and the Text Tools software enabled a new way of collecting evidence in a spontaneous way.

The mobile technologies have helped to speed up the assessment process, which has in turn encouraged the learner to remain engaged and motivated. The assessor commented 'Without doubt assistive technology has enabled the candidate to achieve a full NVQ in a very short time frame, yet produce the quality of assessment that meets the rigour of the college quality standards'

Furthermore, there has been reduced disruption in the workplace from the employer's point of view because of this streamlining effect. College management explain that 'What we can also see is benefits both to the assessor and the employer for work-based learning in that we can deliver and assess in a way that meets the learner's needs and the employer's needs with as little fuss and disruption as possible. This can only be positive.'

6.3.3. Lessons learned

The assessor involved in this case studied reported that 'You need to be prepared to spend the time to learn how to use the technology effectively. The more you learn the more useful it becomes. Initially there are issues relating to quality and efficiency. The long-term potential for assistive technology is phenomenal and this case study has only shown the difference that it has made for one candidate and one assessor who are both dyslexic.'

6.3.4. Future plans

Following this successful implementation of mobile learning in the workplace, Accrington and Rossendale College intended to build on this by ensuring all courses have access to documents and resources on the VLE and by making greater use of Skype as discussed in this case study. They also planned to promote sustainability of mobile teaching and learning by developing staff development and dissemination opportunities and making the most of learner owned devices. The college management explain that 'As a college we can now look at how mobile learning can be embedded into whole college processes to ensure sustainability. Investing in the "Superusers" framework so that we can ensure that the expertise developed during the project can be disseminated to other staff will allow us to continue with this type of work.'

7. CONCLUSION

For many institutions involved in MoLeNET the impact of mobile devices on their work-based and vocational learning provision has been highly significant. Benefits have been experienced in terms of flexibility and personalisation of learning, engagement of learners, teachers and employers, communication and access to learning opportunities, and perhaps most importantly, improved performance and achievement.

Many projects have reported that the introduction of mobile devices has proved highly beneficial for flexibility and access to learning. Learners can access resources and opportunities at a time and place that is convenient for them, fitting their learning around other commitments. The devices have allowed learners to work at their own pace and revisit sessions or resources to aid learning and for revision prior to assessment. They have helped learners organise their work and time, and generally put the learner in control.

Many learners have benefitted from access to IT and the internet where previously it was unavailable. As well as positively impacting on the learner's ability to access resources, projects have reported improvements in the ease with which teachers and learners can create resources and content.

Projects have reported improvements in engagement that can be attributed to several aspects of mobile learning. The technologies have been shown in many cases to make assessment processes easier and less stressful, and teaching sessions more relevant, interactive and enjoyable. Learners have reported feeling a greater sense of being part of the college and the learning community as a result of greater opportunity for communication and collaboration.

Several of the projects involved in MoLeNET have reported improvements in learner retention and achievement rates, which they attribute to the introduction of mobile technologies. It was felt by many that the simplification and improvement of assessment processes has allowed learners to evidence their skills to a higher standard, progress on their courses more quickly, as well as providing opportunities for reflective practice.

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Future Directions

Full Papers

Context-Aware Content Adaptation in mLearning

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Abstract

The increasing use of mobile devices has led to the development of new applications to carry out daily activities anywhere and anytime. In education, teachers are trying to integrate mobile applications into learning tasks and activities in order to enhance the students' learning experiences. However, the majority of the available learning contents and tools have been designed for desktop computers, so accessing that information is limited by the technical capabilities of mobile devices. As a result, if learning personalization processes are not well designed, students might lose interest and motivation to learn using mobile devices. In order to personalize the learning process, and overcome heterogeneity issues, learning contents and tools must be adapted considering student characteristics. Mobility of the students is our focus to present a context-aware content adaptation process. Deciding which variables of the students work context can be addressed in instructional designs to define how the contents in a learning management system (LMS) can be adapted is presented in this paper. In order to design the adaptation process, context characteristics such as mobile devices, place and time of access, and state of physical environment were considered. Moreover, to build the adaptation process a transcoding mechanism that allows a Unit of Learning (UoL), a learning design structure that follows the guidelines of the standard IMS Learning Design (IMS-LD), to provide contents automatically adapted to the students mobile device is presented.

Keywords

Mobile learning, learning design, context-awareness, adaptive hypermedia system.

1. INTRODUCTION

The number of different mobile devices available on the market has increased enormously in the last two decades. These devices present different technical characteristics and offer a variety of information-access possibilities. With mobile computing and adaptive mechanisms, that variety is achieved by analyzing device limitations, as Jäppinen et al. (2004) suggest, and considering different user mobility issues to build adaptive mobile systems that let users accessing information in any situation using the device of their preference.

Mobile devices combine tools and services and can be accessed anytime and anywhere, and because of this advantage people have tried to integrate them into their daily lives. In education, some of those tools and services have been used to propose a new way of learning, a mobile learning (m-learning), in which students can perform tasks anytime and anywhere, changing the ways they usually perform their learning activities, as Traxler (2009) and Kukulska-Hulme (2009) explained in their research work. Kinshuk et al. (2003) propose an appropriate definition: "m-learning is defined as the ability of using handheld devices to access learning resources".

Nevertheless, the application of m-learning in education has focused only on using new technologies, services and tools rather than on personalizing the learning process and monitoring the student activities. According to O'Connell (2007), in m-learning environments it is important to help students create mental maps of the information and contents they are viewing so they can plan and follow a sequence of learning activities to acquire the knowledge and achieve the objectives defined.

The development of a learning activity adaptation process to deliver content and tools to the students' mobile devices while they follow an activity structure defined in a pedagogical model may help to overcome the restrictions associated with mobile devices (Sampson et al., 2007) and provide support for teachers who monitor students' learning processes.

Nowadays, research in the development of learning management systems (LMSs) is aimed at constructing adaptation processes that considers different user traits such as learning profiles, interests, knowledge levels, and others described by Brusilovsky (2007). Our research considers student characteristics related to their context such as the technical capabilities of mobile devices, time of access, location, and conditions of the physical environment, in order to identify the optimal ways that both contents and tools, available in that type of systems, can be presented to students while they follow the activity structure through a defined core learning design of the course.

Considering detection of the context's characteristics and the elements involved in a learning design standard which allows representing pedagogical models over a LMS, a content adaptation process is presented in this paper. The process includes adaptation mechanisms executed at two different times: design-time and run-time. Through these mechanisms the context information can be detected, multimedia resources included in learning design can be used, conditions and adaptation rules can be evaluated, actions that enhance the presentation of resources and tools can be performed, and appropriate transformation jobs can be executed to automatically deliver content adapted to the student's preferred device.

Moreover, to design and implement the adaptation mechanisms, the OMA Standard Transcoding Interface

(OMA-STI, 2005) which let defining content transcodification requests, and the WURFL specification (WURFL, 2009) which defines the profiles of many mobile devices in an XML structure that has data related to their technical capabilities such as hardware, software, network, etc., are applied. The guidelines of the IMS-LD standard (IMS-LD, 2003) are also considered because it defines a structure that uses different elements to design pedagogical models over LMSs and let defining properties and conditions in that structure to implement adaptation mechanisms (Burgos, 2006).

This paper is organized as follows. The second section describes which characteristics are considered as context in m-learning. In the third section mobile content adaptation mechanisms and approaches are explained as background. In the fourth section the architecture and the implementation of the context-aware content adaptation is explained, and some testing results of a transcoding mechanism implemented are presented. Finally, some conclusions are drawn and future work is recommended.

2. CONTEXT IN M-LEARNING

Properties of the students' situations such as the place and the conditions of the physical environment from which they are attempting to access, the time of access, whether they are completing indoor or outdoor tasks, and the technical elements involved in interactions with a system (e.g. capabilities of the mobile device, artifacts that detect and capture related information about students, etc.) are characteristics of what can be called context. According to Dey (2000) this term is briefly defined as "any information that can be used to characterize the situation of an entity", understanding the term "entity" as anything relevant participating in the interaction between a user and a system, such as a person, a place, or an object, and including the user and the system.

Considering students mobility, different learning activities may be defined in a course core curriculum, and depending on the characteristics of the student's situation those activities can be either recommended (Martín et al., 2006) or adapted (Jäppinen et al., 2004). For example, a teacher defines in the learning design of a course that students review an audio file of a lecture and a video file that explain the main idea of a subject in order to participate in a discussion chat (using an instant messaging tool) that will be held at a planned time (teacher's tutoring disposal time). The teacher uploads to a LMS the audio in .wav format and the video in .avi format. One student can participate in both activities (a reviewing task and a collaborative discussion task) using a personal computer from home without any problem (considering that she has an internet connection and the files can be downloaded), but how can those activities be presented to the student if she wants to complete them on a smartphone while she is out of the house? The challenge in m-learning scenarios is that both tasks could be held in the student mobile device anyplace at the time set by the teacher, without any problem as well, even if the audio and video files were not designed considering the capabilities of the device.

In such m-learning scenarios the context can be disaggregated into two parts: one related to the structure of a learning design, considering the learning paths and activities that students follow and perform respectively in order to acquire the knowledge; and other related to a ubiquitous and mobile environment in which students and teachers interact performing those activities. Siadaty et al. (2008) called these two categories *learning context* and *mobile context*.

Learning context can be described by the learning design process, where authors represent pedagogical models by defining learning activities as procedural structures, identifying different objectives that students have to achieve and considering different activities and contents that teachers define in order to guide and follow the students' learning process.

Mobile context can be referred to as context information such as mobile device capabilities, geographic location, light level, sound level, students' movements, etc., which can be captured by hardware or measured by sensors. We have used a suitable classification of mobile context information proposed by Christopoulou (2008) that defines five parameters (user, artifact, place, time and physical environment).

In a good m-learning environment, applications or adaptation mechanisms can be designed by performing learning activities with an LMS in mobile scenarios and identifying variables from the two categories of the context that can be reflected in a mobile learning process.

3. MOBILE CONTENT ADAPTATION

With the increasing development of learning multimedia resources (e.g. images, audios, videos, web contents, etc.) and learning tools (e.g. collaborative tools, search engines, web translators, social network services, etc.) for e-learning environments, new learning activities can be proposed to enhance students' learning experiences. However, in m-learning environments, providing those kinds of resources and tools while taking into account some limitations of mobile devices such as limited screen sizes, limited memory available for page rendering and limited types of content supported (W3C-MBP, 2008) may cause the loss of information for learning and the failure to achieve the learning objectives if adaptation processes are not well designed and implemented.

3.1 Mobile Adaptation Mechanisms

According to Bomsdorf (2005) mobile content adaptation commonly consists of content filtering, application filtering, polymorphic presentation and content classification. We considered the processes of content filtering, specifically by means of tool or resource selection, and polymorphic presentation, through learning content transformation, as adaptation mechanisms.

3.1.1 *Tool or resource selection*

Through learning design authors can represent pedagogical models with learning procedural planning that defines different learning objectives and various teacher-defined activities to guide and monitor the students' learning processes. The authors can also define which learning contents allow those activities to be completed and the environments that include the resources and tools to facilitate activity completion.

IMS-LD is a standard that provides a generic and flexible language to model and implement the learning design and express different pedagogies (IMS-LD, 2003) in XML structures. IMS-LD establishes the guidelines to build a Unit of Learning (UoL), which is the smallest unit that provides learning events for students, satisfying one or more inter-related learning objectives.

In order to implement the specification in a LMSs, a UoL can be built on three different levels—A, B or C—providing different schemes of an XML file at each level that can be integrated in a LMS in consideration of authors' purposes. Level B adds the possibility of defining conditions to evaluate different expressions based on properties related to a single user or different roles in order to enable the personalization and adaptation (Koper, 2005). In UoL level B, authors can define properties and conditions according to the information detailed in a model (e.g. context, student, content, learning flow, etc.) in order to execute an adaptation action: show, hide, change a value to a property or notify.

In our work, tool or resource selection consists of making decision processes using IMS-LD conditional statements to evaluate the context's characteristics in order to show or hide available learning tools and resources.

3.1.2 *Content transformation*

A transforming process consists of a set of steps to transcode the properties (format, type, size dimensions, quality, etc.) of one or more multimedia resources. Two factors are considered for its application: 1) the technical capabilities of the user's device (i.e. browser, network connection, display, media support, etc.), 2) the characteristics of the users. Considering all kinds of possible scenarios where users can interact with systems, finding the most appropriate transcoding strategy is not a simple task. Moreover, a transcoding process can be run at any given time due to users' needs, preferences, tasks, activities, etc.

Mirri (2007) describes some examples of transcoding processes and gives details about different transformation mechanisms. One example is the conversion between encoding formats for the same content. (e.g. WAV format files can be converted to MP3 formats). Another example is degradation of the content, such as changing text to speech (text-to-speech) or vice-versa (speech-to-text), or changing animated images to still images. Other examples consider changing the dimensions of the resources and may include data compression, reduction in quality rates or reduction in size rates.

In our work, the content transformation consists of content transcoding/recoding processes that let personalizing the file format or the properties of the multimedia resources according to different parameters based on clients requests or device capabilities.

3.2 Mobile Adaptation Approaches

W3C in W3C-MBP (2008) has categorized three approaches to where the adaptation is implemented and performed: client-side, server-side and proxy-based. Although in the client-side approach the client platform has the entire device's capabilities description (Lei, 2001), performing a transcoding process is very limited due to the lack of computing power and bandwidth.

On the other hand, the server-side approach overcomes the limitations of the client-side approach. A server with a device detection mechanism and device profiles in a storage repository can compute a client's content delivery requests and optimize and adapt the content according to the technical capabilities of the device (Xinyou et al., 2008).

In a proxy-side approach the adaptation occurs between the server and the client in different nodes (Li et al., 2006), where the content is received and altered, as it passes through one or more network components. However, the use of network connection bandwidth can be demanding on the link between the server and the proxy.

The adaptation process we present was defined to be deployed considering the server-side approach (receiving requests and capabilities of the device and responding with adapted resource delivery) mainly because it presents two advantages: 1) Learning content properties, device capabilities, information about context, adaptation rules, and other data can be stored in repositories located on the server, and an LMS, a transcoding server, IMS-LD files and multimedia resources can be stored there too. 2) Transcoding processes (request reception, transformation and response delivery) and user interaction with the LMS can be performed simultaneously.

4. CONTEXT-AWARE ADAPTATION PROCESS

An adaptation process to deliver content to students' mobile devices based on the detection of context information (device, place, time and physical environment) was designed and partly tested. As first approach a transcoding server was included in the process to run several content transformations according to the capabilities of different mobile devices and to generate adaptive UoL (structures of IMS-LD level B) by adapting the resource files referenced within its structure.

Initially, four main groups and different mobile device types were defined to analyze which technical capabilities should be considered to identify the parameters the content should have before being properly adapted (see Table 1).

Table 1. Mobile Devices Groups

Group	Types	Examples
Mobile phones	Feature phone	LG EnV Touch, Samsung Mythic, Sony Aino
	Smartphone	Blackberry, iPhone, HTC, Nokia N900
Personal Digital Assistants (PDA)	Low-end PDA	Palm Zire
	High-end PDA	Pocket-PC, HP-iPAQ, Dell Axim
Tablet Computers	Ultra-mobile PC (UMPC)	Microsoft UMPC, VilivX70, Samsung Q1
	Tablet PC	iPad, HP Slate, Dell mini 5
Media players	Media player	iPod, Samsung S3, Creative Zen X-Fi
	Portable gaming console	Sony PSP, Nintendo DS

The analysis consisted of studying the technical capabilities related to connectivity, network, display, memory, operating system, browser and support of audio, video, images, text, dynamic content and markup language generally presented in the mobile device types shown in Table 1. In the analysis, the capabilities described in the WURFL specification and the report of the Australian Flexible Learning Framework project presented by O'connell, (2007) as a guide for using mobile learning standards were considered. Although, there are more solutions that describe the device capabilities (e.g. UAProf, CC/PP, etc.), we selected WURFL because is an up to date specification that brings reliability in device data manipulation.

Additionally, to identify content transformation parameters, the properties of different types of multimedia resources that can be customized by a transcoding mechanism were reviewed (see Table 2). Some of the guidelines and recommendations presented by Low (2007) were followed in our work, specifically the resource-related properties of type audio, video, images, standard documents, web content, and dynamic content.

Table 2. Resource types and properties

Resource	Properties
audio	content type, sampling rate, channels, bit rate
image	content type, color scheme, width, height
video	content type, Visual (width, height, frame rate, bit rate), Audio (sampling rate, channels, bit rate)
text	content type
web content	content type
dynamic content	content type

The adaptation process takes place at two times—design-time and run-time—and each time consists of three phases. At design-time one phase describes the edition of UoL (using properties and conditions) and at run-time the detection of the context information. The other two phases describe a dynamic adaptation where learning resource transformation occurs, and adapted UoLs are generated referencing the transformed resources.

4.1 Adaptation Process at Design-Time

At design-time (see Figure 1) properties and conditions from the IMS-LD standard are used to adapt contents taking into account context information related to *place*, *time* and *physical environment*. The *device* information is taken into account to generate transcoding requests for the media resources referenced within an edited UoL.

4.1.1 UoL Edition phase

Learning design authors can edit and build a UoL for a core course curriculum following the guidelines of the IMS-LD standard, including learning resources that students have to review. To consider the characteristics of context in learning design, authors can use the properties and conditions allowed by the IMS-LD level B structure.

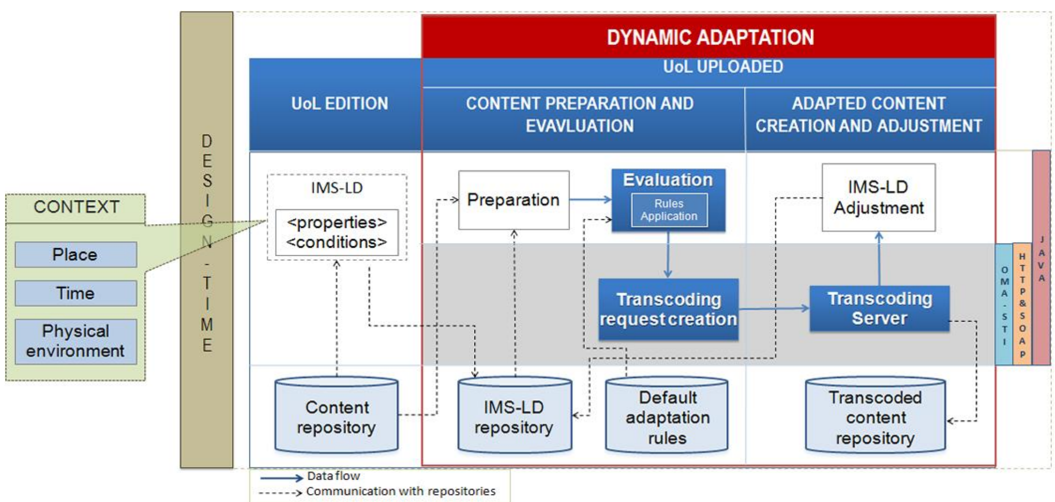

Figure 1: Adaptation process at design-time

Based on the information that can be detected from the parameters *place*, *time* and *physical environment*, conditional structures would consist of IF / THEN / ELSE statements that select the available learning resources for later presentation according to the conditions of the students' situation. An example of the use of properties and conditions is illustrated by the following pseudo-code:

```
Properties:
user_location, zone, illumination, time_hours.
Conditions:
    IF user_location IS library
    AND zone IS private
    AND illumination IS low
    AND time_hours ISGREATER-THAN 18:00
    AND time_hours ISLESS-THAN 20:00
    THEN:
    SHOW resources of type images and web content that have big
    letters and bright colors.
    HIDE resources of type audio and video
```

Therefore, the adaptation process is proposed to includes the evaluation of a set of conditions according to the context information that can be detected related to the *place*, *time* and condition of the *physical environment* where the student is accessing in order to implement *show* or *hide* actions for learning resources or tools.

4.1.2 Content Preparation and Evaluation phase

Considering the context information related to the *device*, when an edited UoL is uploaded to a LMS, a set of predefined adaptation rules are followed (see Table 3) to instantly execute the adaptation process, store the learning-adapted content, and make them available for students when they are interacting with a LMS (adaptation process at run-time).

The adaptation rules describe the transcoding values that should be assigned to some parameters of audio, image, video, text, web content and dynamic content resources according to the capabilities of four *default delivery device profiles.* From the analysis of the technical characteristics of the mobile devices four *default delivery device profiles* (smartphone, high-end PDA, Tablet PC and portable gaming console) were selected because they present generic technical capabilities that can be used to obtain, initially, some adapted resources.

Furthermore, OMA-STI resource parameters in table 3 were selected after analyzing the relation between the allowable device capabilities in WURFL and the allowable resource properties in the transcoding guidelines of the OMA-STI specification (Gómez et al., 2009).

At the end, the adaptation rules are used to create a set of transcoding requests for the multimedia resources used in the UoL edition phase and to generate four adapted UoLs (one for each device profile) that can be delivered to the student mobile device at run-time.

This phase consists of three modules (see Figure 1):

i) Preparation: Identifying and locating the resources used in the edition of a UoL.
ii) Evaluation: Applying the adaptation rules to the identified resources.
iii) Transcoding request creation: Receiving a list of learning resources and transcoding parameter values defined in the adaptation rules to create a set of transcoding requests.

In Table 3 some transcoding values are the same for some device profiles but in this module a process to create transcoding requests should not be repeated in those cases. The guidelines of the OMA-STI specification, which can be used to initiate and finalize a content-transformation process, were followed to implement the transcoding requests.

Table 3. Resource adaptation rules for default delivery device profiles

		Mobile phones	PDAs	Tablet computers	Media Players
		Default delivery device profiles			
Resource		Smart	High	Tablet PC	Portable gaming console
Type	**OMA**	**Transcoding values**			
Audio	contentType	mpeg	mpeg	mpeg	mpeg
	samplingRate (Hz)	44100	44100	44100	44100
	channels	Stereo	Stereo	Stereo	Stereo
	bitRate (bps)	96000	96000	128000	96000
Image	contentType	jpeg	jpeg	jpeg	jpeg
	colorScheme	True	True	True	True
	Width (pixels)	240	240	1024	480
	Height (pixels)	320	320	600	272
Video	contentType	mpeg4-generic	mpeg4-generic	mpeg4-generic	mpeg4-generic
	Visual	144	144	480	480
	Visual	176	176	272	272
	Visual	5	6	24	6
	Visual	45000	50000	300000	50000
	Audio	44100	44100	48000	44100
	Audio	Stereo	Stereo	Stereo	Stereo
	Audio	32000	32000	96000	32000
Text	contentType	application/pdf	application/pdf	application/pdf	-
Web content	contentType	XHTML	XHTML	XHTML	XHTML
Dynamic content	contentType	javascript	javascript	javascript	javascript

The Alembik transcoding server (Alembik, 2008), an open source, java-developed server whose architecture is based on the use of HTTP and SOAP protocols, was used in this phase. Moreover, the architecture of the Alembik Server considers the WURFL specification and the OMA-STI guidelines to provide a standardized interface that allow communicating with different transcoding engines.

Transcoding jobs with the new properties for each resource are performed by the transcoding server. After the resources are transcoded/recoded they are stored on a transcoded content repository, which is defined as a cache repository because the adapted content can be reused insofar as an adapted UoL uses that content in its structure.

Finally, as outcome of the adaptation process at design-time four new UoL structures (one per each *default delivery device profile*) are built and new adapted versions of the resources are adjusted to them. Those UoL are stored in a repository of IMS-LD where they will be available for delivery at the run-time.

In order to verify the adaptation outcome after passing through the transcoding process, some adapted resources are reviewed. In Figure 2 four adapted versions of an image type learning resource reviewed on different mobile browser emulators are presented. Also, in Figure 2 the values of the parameters (content type, color scheme, height and width) that were used to perform the transcoding process are illustrated.

4.2 Adaptation Process at Run-Time

Adaptation at run-time (see Figure 3) differs from adaptation at design-time in the moment that the phases are executed. At run-time the execution begins when students are interacting with an LMS and request to follow a UoL. Furthermore, at run-time a set of adapted UoLs, created at design-time, are available and can be delivered after checking if the mobile device that a student is using during the interaction meets a set of device capability criteria related with the transcoding values proposed in the adaptation rules. Finally, if the capabilities of the access device do not meet the criteria, new transcoding jobs must be performed on the go to adapt the resources.

4.2.1 Detection phase

At run-time the context information related with the *device, place, time and physical environment*) is detected on the go.

The context information related to the *place*, *time* and *physical environment* are proposed to be detected from the student mobile device by receiving information from or sending information to identification, location or sensing technology devices, which could be placed in places where students frequently interact with systems, for instance, in different zones of a campus, inside a museum, inside the house, etc. These detection mechanisms may enhance adaptation processes by considering characteristics different from the mobile device capabilities.

At this phase student mobile *device* capabilities are considered to be detected and to implement this detection the WURFL specification is used.

4.2.2 Validation and Content Preparation phase

After the Detection phase, the validation of mobile access device capabilities may allow adapted UoL and content to be delivered immediately.

In the Validation module it is determined whether the student mobile access device is capable of accepting the resources transcoded at design-time. Otherwise the delivery incompatibilities of the device are determined to generate more detailed transcoding requests considering its capabilities.

The validation of device capabilities must be a process without delays, as there may be much content and many tools, available on the structure of a UoL, that have to be delivered.

			
Smartphone (emulator)	High (HTC Blue Angel PDA browser emulator)	Tablet PC (	Portable gaming c (Sony PSP browser emulator)
ContentType: jpeg ColorScheme: True Height: 320 pixels Width:240 pixels	ContentType: jpeg ColorScheme: True Height:320 pixels Width: 240 pixels	ContentType: jpeg ColorScheme: True Height: 600 pixels Width: 1024 pixels	ContentType: jpeg ColorScheme: True Height: 272 pixels Width: 480 pixels

Figure 2: Transcoded versions of an image resource

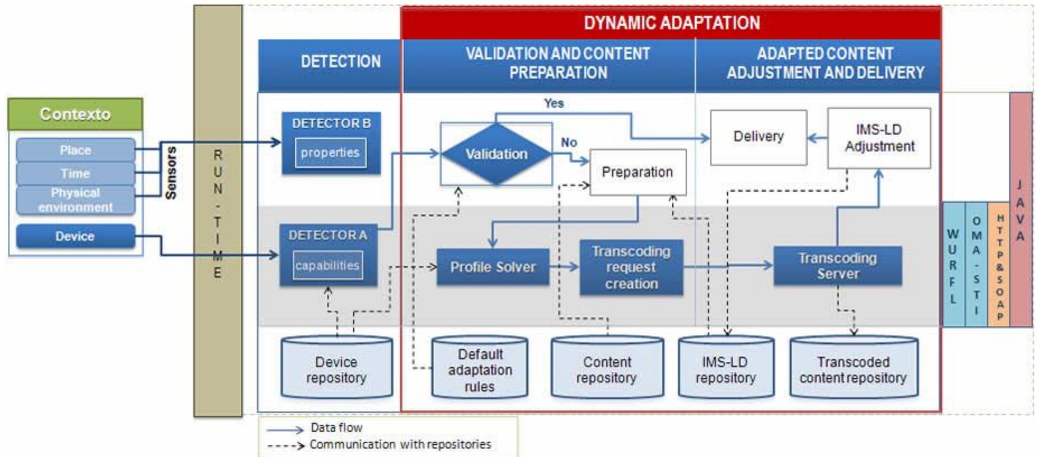

Figure 3: Adaptation process at run-time

The validation consists of two options:

- If student device capabilities present values that are included in a set of accepted values defined, previously adapted resources at design-time are immediately delivered. The accepted values of the capabilities defined for validation are presented in Table 4.

Table 4. Accepted parameters' values for validation process

Target resource	OMA parameters	WURFL group	WURFL device capabilities	Accepted values
Audio	contentType	sound_format	mp3, aac	true
Image	contentType	image_format	jpg	true
	colorScheme	image_format	colors	16, 32, 256
	width	display	max_image_width	≤
	height	display	max_image_height	≤
Video	contentType	playback, streaming	playback_mp4, streaming_mp4	true
	Visual - width	display	max_image_width	
	Visual - height	display	max_image_height	≤
Text	contentType	pdf	pdf_support	true or false
Web content	contentType	markup	xhtml_support_ level	≥ 0
		markup	multipart_support	true
Dynamic content	contentType	ajax	ajax_support_ javascript	true or false

- Otherwise, if any of the access device capabilities do not meet with the accepted values for those capabilities (i.e., the device has limitations to receive adapted resources), a content preparation process is started (a similar preparation process as implemented for design-time).

After the resources are identified and located within the structure of the edited UoL that the student is trying to follow, the resources are sent to the Profile solver module to match their properties with the capabilities of the student mobile device detected. In run-time process the transcoding values for the resource parameters defined correspond with the capabilities of the student mobile device and are obtained matching the mobile device user agent with its profile in the WURFL specification. Thus, the Profile solver module will send a list with the transcoding parameters of the identified resources to the Transcoding request creation module.

Finally, after receiving the transcoding parameters and the list of resources, the Transcoding request creation module creates XML transcoding request structures following the guidelines of the OMA-STI specification.

4.2.3 Adapted Content Adjustment and Delivery phase

The result of the transcoding process is the generation of resources and a UoL adapted to the capabilities of the access device that the student is using, and are stored in the transcoded content repository and in the IMS-LD repository respectively.

As with design-time, in the transcoding server transcoding jobs with the parameters values of each resource are processed. The process ends by delivering the adapted UoL and the resources referenced within it to the student mobile device.

5. CONCLUSIONS AND FUTURE WORK

M-learning is not only about including mobile technologies in traditional learning activities; it is about how the students take advantage of mobile technologies to enhance their learning process: doing the learning activities anytime and anywhere, and allowing them to achieve the learning objectives defined in a core course curriculum.

Including the information of the context to adapt the elements defined in the learning design for a course, is an issue of interest where many research communities are working to enhance the student´s learning experience. According to this, we have presented a context-aware adaptation process that delivers automated adaptive UoLs.

Implementation of the process was made for Design-Time using a content transcoding mechanism and defining some conditional statements in the structure of the IMS-LD standard taking into account the information of the context (place, time and physical environment) to perform, show or hide actions for the learning contents. As future work implementation of the adaptation process at Run-Time including a mechanism to evaluate the context-based conditional statements is proposed.

In the future, we propose to implement detection mechanisms, using location and sensing technologies, for the context information related to the place and time of access and state of the physical environment. Using that information may enhance de delivery of learning activities.

6. ACKNOWLEDGMENTS

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W3C-MBP Mobile Web Best Practices 1.0, 2008. W3C [Online] Available at: http://www.w3.org/TR/mobile-bp/ [Accessed 17 January 2009].

WURFL Wireless Universal Resource File, 2008 [Online] Available at: http://wurfl.sourceforge.net/ [Accessed 20 January 2010].

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Advanced Mobile Lecture Viewing: Summarization and Two-way Navigation

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Abstract

While printed material has gained in versatility with its analog-to-digital passage, video recordings have largely remained stalled with no new functionalities. In the case of recorded lectures, the lack of flexibility in contents' navigation due to video's linear nature, results all more shocking for the Generation Y of learners who have come used to finding and consuming information at will. In this work we present a fully automated blackboard-based lecture solution consisting of a robust summarization tool and an innovative mobile iPad visualization tool. Both combined offer learners a novel way to discover and revisit lectures by offering general overview and visual timelines in addition to intuitive spatial navigation that allows exploring recordings by directly touching blackboard regions from the video. The result of this work is two-way non-linear lecture navigation that aims to bring to recorded lectures most of the benefits that other digital learning material has long enjoyed.

Keywords

Recorded Lectures; Blackboard Analysis; Mobile Learning; iPad; Video Summarization; Video Skimming.

1. INTRODUCTION

For quite sometime video has been used to record lectures for distance learning and reviewing (Brofferio 1998). Indeed video has the power to capture and reproduce more lecture features than any other available media like text transcriptions or audio recordings: in addition to presenting text and illustrations, video also conveys lecturer's speech and gestures as well as interactions with the audience.

Recording and sharing lectures has also got a lot easier in recent years as there is no need for dedicated recording crews, invasive capture devices or specially tailored classroom environments. In sum any lecturer could nowadays setup a tripod-mounted camera and record his entire presentation to share the resulting video using the Internet (Soong et al. 2006).

1.1 Going All Digital, and Mobile

The enthusiast way our education community embraces new technologies can be first explained by the effectiveness at creating and delivering digital learning material. Additionally with the advent of mobile platforms, reaching learners has never been this straightforward (Ormond 2008).

A second reason why eLearning has been received so warmly is the fact that *most* learning material has been significantly enhanced when going digital. For example textbooks and printed material have gained in interactivity and navigability allowing students to browse text and image-based material in the order that best suits their learning path while skipping unneeded content.

Notable exceptions to such digital enhancements are lecture videos. And even though producing recorded lectures is more accessible and popular than ever, we cannot help wondering if at the other end students will be genuinely interested in the resulting videos. After all a typical lecture repository contains multi-megabyte files and dozens of video hours of overwhelmingly indistinguishable content.

1.2 Video's Media Limitations

Ever since becoming mainstream video in general has largely remained unchanged. From videotape recordings to high definition broadcasts, all conceived with entertainment content in mind, video is still a linear medium. While most general videos can be watched from beginning to end sequentially, and knowledge about the actual contents or their structure is not critical, recorded lectures are not suitable for such passive viewing.

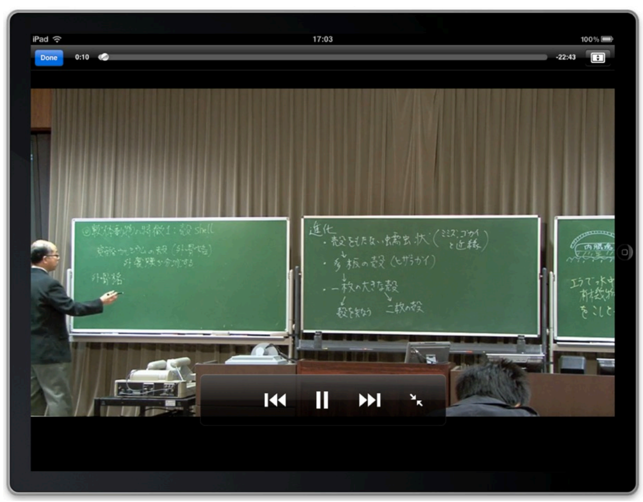

Figure 1: A recorded lecture viewed with a regular iPad video player

A typical video player, such as the one illustrated above, doesn't provide navigation cues other than an inexpressive timeline with no other information besides the current playing position while contents remain obscure (Figure 2).

In most cases users have no other option than unpleasantly jumping around the video, or even worse, skipping recorded lectures altogether.

Figure 2: Detail of the limited navigation timeline of Figure 1's video player

With this work we intend to provide learners with an overview of recorded lecture contents to enable them to precisely find sections of interest without guesswork. At the same time we aim to leverage videos interactivity and navigation features using visual vignettes and allowing them to be directly touched, in what we call *spatial navigation*.

In the next section we describe the automated summarization tool we developed for blackboard-based recorded lectures while in Section 3 we present our mobile visualization tool that combines lecture videos with our summarization output to provide a novel lecture viewing experience.

2. SUMMARIZING LECTURES

Summarization consists in discarding highly similar video sections while retaining only the most significant elements to succinctly describe the contents of the video. Automated summarization is a hot research topic with lots of work done towards characterizing general videos where edition cuts, different camera angles, recording locations and multiple characters can clearly mark shot boundaries greatly simplifying scene's feature extraction (Smith and Kanade 1998). Summarizing documentary educational videos (Luo, et al. 2008, Song et al. 2010) shares many aspects of general videos' summarization techniques with visually recognizable scenes. As for slides presentation-based lectures they can be summarized using already structured source files (Mukhopadhyay and Smith 1999).

On the other hand blackboard-based recorded lectures lack dramatic scene changes and don't follow rigid paths or reference presentation files. All the action takes place in an immutable indoor classroom and the main character, the lecturer, is by far the only central character. Resulting recordings are all too similar for general summarization tools not suited to sense subtle changes. Existing blackboard analysis work requires multiple cameras (Onishi et al. 2000) or fixed overhead camera for handwritten slides (Ju et al. 1998). Hence our need to develop a new summarization tool that only requires a single manned or unmanned camera, that works with raw or edited content and that is fully automated for maximum flexibility and convenience.

It is important to note that our objective is not to enhance the video qualities of recorded lectures (Yokoi and Fujiyoshi 2004, Heck et al. 2007), but to describe the evolution and contents of a lecture session.

2.1 Blackboard Edits as Summarization Cues

Although many new teaching tools, such as projectors, monitors and laptops have been introduced to classrooms, the omnipresent blackboard, and its modern variants, still play a major role in today and future's education. While slide presentations may be pointed-out as blackboard's natural replacement, slides cannot be changed, improvised or adapted "on the fly" in response to audience's reception, students cannot add their own content and their interaction possibilities are very limited at best. This is especially unsuited for lectures of fields such as mathematics and physics where developing students' reasoning skills and active learning are central.

As we concentrate in blackboard-based recorded lectures we intend to analyze blackboard's development: as the session progresses, the lecturer and students add and remove content in a sequence of *blackboard edits*. Edits are not individual chalk strokes but all the contents written "at once" before revealing them to the audience. Edits represent significant descriptions of the lecture and we intend to use them as *summarization cues*.

In this work we are not aiming at exhaustively extracting all blackboard contents to create a lecture "handout" (Choudary and Liu 2007), nor we intend to apply trained-based handwritten recognition (Plötz et al. 2008) but to extract only the most relevant blackboard features that can visually summarize a recorded lecture.

2.2 Comparing Video Frames

The basis of our analysis relies on comparing video frames to highlight their differences:

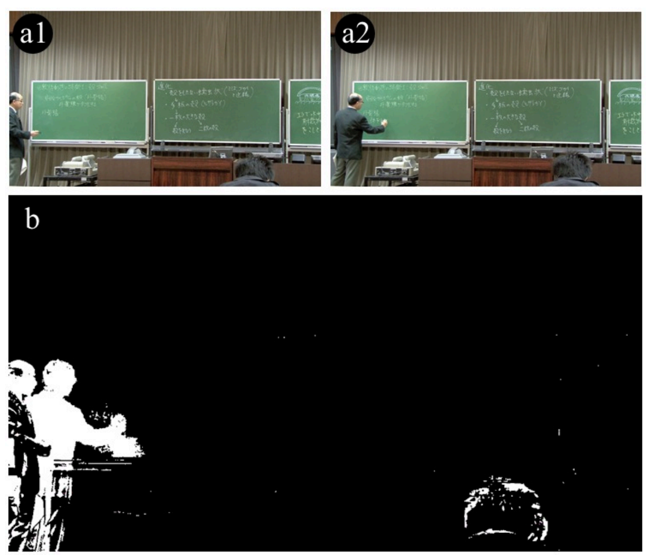

Figure 3: Two video frames (a1, a2) and their binarized difference (b)

- Two frames are compared together applying pixel-by-pixel subtraction.
- We discard color information and binarize the image, meaning that only differences in the scene between the

two frames get marked in white color, while zones that remained mostly unchanged become black (Figure 3b).

While a resulting *binarized difference* may contain our desired blackboard edits, most of the highlighted zones represent lecturer and audience movements or undesired obstructions that need to be cleared.

2.3 Getting a Clear View

2.3.1 Keyframes

With video rates of about 24 frames per second we discard highly redundant frames by sampling only one frame every second without losing significant information.

As most of the sampled frames have obstructed blackboard zones, we choose a few *keyframes* where these zones are clear for viewing. Keyframes are chosen in a way that ensures that occluded sections of the blackboard in a given keyframe will be visible in the next keyframe as illustrated in Figure 4. To achieve this we *maximize* the difference between sampled frames:

- We start by choosing an arbitrary first keyframe k^0, which is then binary compared (as described in 2.2) with succeeding sampled f^i frames located at one-second intervals.
- While frames close to k^0 will only present marginal differences, as we advance in time and the lecturer moves, the differences increase until at some point start decreasing as the lecturer goes back to his original position. It is at this moment that the next keyframe k^1 is chosen, thus maximizing the scene differences with k^0. Typically a new keyframe will happen when the lecturer stands occluding a different blackboard region (Figure 4b, c, d).
- The process is iterated with k^1 as our new reference keyframe, and continues until all keyframes for the recorded lecture are defined.

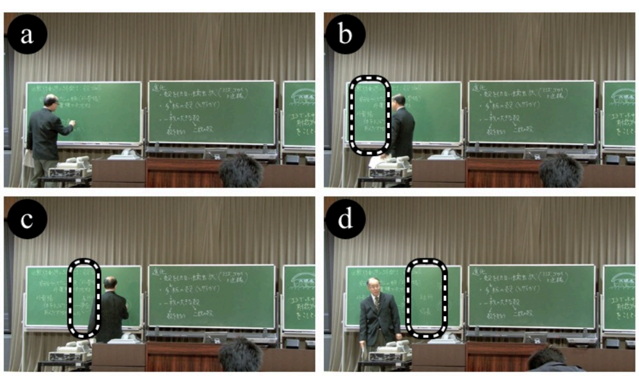

Figure 4: Successive keyframes. Notice how hidden sections (dotted zones) get revealed in successive keyframes

With our algorithm, frames with minor lecturer or audience movements, among other superfluous scene changes, get discarded in the process.

2.3.2 Obstruction Masks

Before further analyzing keyframes we calculate their *obstruction masks*, that is to calculate the zones of the frames where obstructing objects appear. Such objects are essentially the lecturer and sometimes the audience, as in Figure 5b where besides the lecturer a student continuously moves his head.

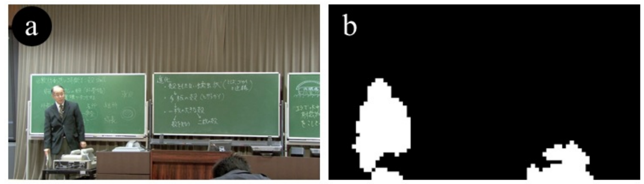

Figure 5: A keyframe (a) and its corresponding obstruction mask (b)

Obstruction masks can be obtained by analyzing the results of binary comparison of a keyframe *k* with neighbor frames at *k-1sec* and *k+1sec*. In both resulting binary comparisons obstructing objects from the two frames plus those from the keyframe will be present; but more important only obstructing objects from our keyframe will be present in both comparisons at the same time, thus simply multiplying comparisons together defines an accurate silhouette of the lecturer and any other important occluding object.

With keyframes and their corresponding obstruction masks calculated we are ready to extract blackboard edits.

2.4 Processing Keyframes

Writing to the blackboard implies drawing slender figures using markers or chalk with colors that visually contrast with that of the blackboard's background color. This simple principle is perfectly adapted for standard *edge detection* algorithms that highlight zones of an image where brightness changes sharply.

Figure 6: Figure 5a's keyframe after processing and after occlusion removal

Our keyframe processing is made as follows:

- To enhance edge detection we preprocess each keyframe by boosting its contrast. Then edge detection treatment discards empty areas of the blackboard while highlighting text and drawings. Edge detection is highly resistant to non-uniformly illuminated zones and to shadows cast by the lecturer.

- Edge detected keyframes get binarized. Moreover standard erosion and dilatation algorithms are applied to suppress salt and pepper noise due to recording artifacts and noise produced from chalk or marker's dust.
- As a last processing step all major occluding objects are removed using the corresponding obstruction mask. A sample of *processed-keyframe* results can be seen in Figure 6.

For sake of simplicity, and for the rest of this section, we refer to processed-keyframes simply as *keyframes*.

2.5 Detecting Blackboard Edits

By subtracting two consecutive keyframes (*before* from *after* keyframes) blackboard edits that took place in between them, if any, will become apparent. The problem is that any other difference, such as flickering objects and subtle occlusions may also appear as the scene as a whole is constantly changing. With the premise that blackboard edits are *persistent* changes, meaning that something written to the blackboard has to stay in the scene in subsequent frames, we can use not only one but several *before* and *after* keyframes to create more accurate *scene state snapshots*. While for both snapshots we chose to use four keyframes, the way the *before* and *after* snapshots are calculated is different.

2.5.1 Blackboard's "Before" Snapshot

The problem in the before keyframe is that by removing occluding objects, as we do in 2.4, we create "holes" where the presence or absence of new content will be impossible to ascertain. For instance if the lecturer occluded some content in the *before* keyframe and moves away for the subsequent *after* keyframe, we still won't be able to conclude if the revealed content is new or if it was already present before occlusion. To solve this we *reconstruct* the state of the blackboard to get a *before snapshot* as free of holes as possible. For this we simply *addition* the *before* keyframe with its previous three keyframes, thus "patching" keyframes' holes.

As we can observe in the sample snapshot of Figure 7a, besides reducing the empty areas also noise from blended keyframes gets added, but as we will see later in 2.5.3, this is not an undesirable behavior.

2.5.2 Blackboard's "After" Snapshot

Here we are no longer interested in patching holes, but rather in suppressing noise and non-blackboard content. Newly made blackboard edits should either remain in subsequent keyframes, or should correspond to empty keyframe zones if occluded by the lecturer. We thus *multiply* the first *after* keyframe with the subsequent three keyframes, while ignoring empty zones. At each multiplication noise gets further reduced, and objects that appear only in single keyframes as well as constantly moving or flickering objects get deleted, all while genuine blackboard contents remain untouched.

The resulting image is a clean *after snapshot* that preserves blackboard content as in Figure 7b.

2.5.3 Comparing Snapshots

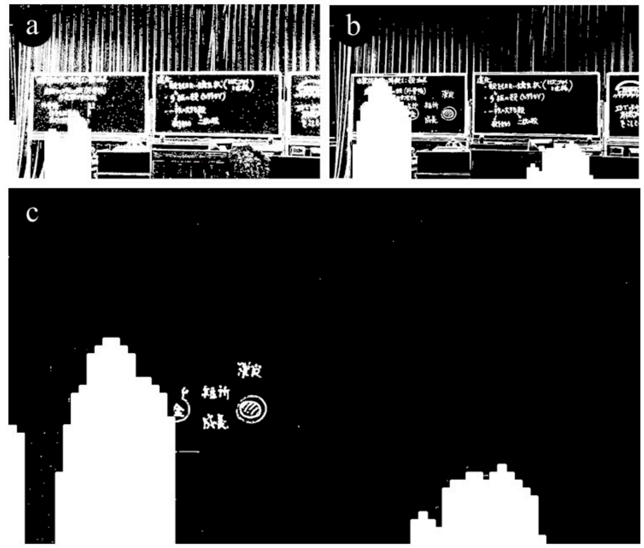

Figure 7: Analysis' before (a) and after (b) snapshots and their resulting detected blackboard edit (c)

For the final step we simply *subtract* all previous blackboard content, scene elements and noise present in the *before* snapshot from the *after* snapshot. The resulting image highlights only new blackboard content written in between snapshots (if any) in white. A sample of analysis detection result can be seen in Figure 7c.

2.6 Summarization Output

```
…
<dict>
     <key>height</key>
     <real>23</real>
     <key>width</key>
     <real>39</real>
     <key>x</key>
     <real>864</real>
     <key>y</key>
     <real>392</real>
     <key>creationTime</key>
     <real>578</real>
     <key>thumbnailTime</key>
     <real>595</real>
</dict>
…
```

Figure 8: Summarization output data corresponding to a single blackboard edit

For every detected blackboard edit, our summarization tool outputs an entry to an XML-formatted text file with the following data:

- *Region of Interest* (RoI), or the detected blackboard edit's bounding box, including an origin point inside the video and the height and width, in pixels, of the smallest rectangular area that fully comprises the edit.

- *Creation time*. An estimation of the time, in seconds, when the edit took place, and also probably the time of the lecture when the corresponding learning subject was being explained. We have experimentally found that the time of the *before* keyframe is a good estimated time as at this time the blackboard edit was not yet present or the lecturer was occluding it while still writing.
- *Thumbnail time*. A time at which the edit is both present *and* visible. We use the time of the *after* keyframe, thus a time when the edit was finished and clear for viewing. This thumbnail time along with the RoI will be later used to create visual vignettes as described in the next section.

2.7 Summarization Remarks

The summarization output is a compact and easy to distribute XML text file of negligible size when compared to that of the source recording while the original lecture remains untouched and no video or additional images need to be produced.

Summarization is a fully automated process. Our tool runs on Mac OS X and extensively uses OpenCL taking advantage of multi-processor configurations and modern video cards.

Even though we prefer unmanned recorded lectures, our summarization tool is resistant to sporadic or accidental camera changes such as zooming and panning, camera relocation, video cuts or multi-camera recordings. In a any of these cases:

- *Before* and *after* snapshots dramatically differ resulting in most of the scene getting marked as one large blackboard edit.
- Once the image gets stabilized for a relatively short time normal edit detection resumes. The needed time is the one required to sample eight successive keyframes (four to create each snapshot), or about 2-3 minutes in our tests (refer to Section 4 for experimental results).

Moreover reducing the number of keyframes used for each snapshot or choosing more keyframes would allow us to detect more camera movement-prone videos. We are however more focused in lecturer-produced videos where neither cameraman assistance nor editing can be afforded, as it is such resource-constrained lectures that would benefit the most from automated video summarization.

Before and after snapshots greatly reduces the negative impact of dust or poorly erased contents as opposed to content-pixel based algorithms (Liu and Choudary 2006).

3. VISUALIZING LECTURES

Visually presenting summarization results along with the recorded lecture in a pertinent and non-intrusive way is not a trivial task. Unnecessary information can quickly clutter the user interface and we must not forget that the main function of the tool has still to be playing back videos.

With these requirements in mind we developed a mobile lecture visualization tool. We decided to go mobile using Apple's iPad and iOS platform in order to reach a growing audience and because of the new interaction possibilities that modern mobile platforms can offer.

Figure 9: Our iPad lecture visualization tool's straightforward interface

The tool plays the recorded lecture like a normal video player but additionally enriches the learning experience with information from our summarization output file. We have implemented advanced *two-way navigation*: timeline navigation, and spatial navigation.

3.1 Timeline Navigation

Two timelines illustrate the lecture contents and its structure. The first timeline presents at a glance a blackboard edits' *overview*, while the second, a *visual timeline*, presents blackboard edits using vignettes.

3.1.1 Overview Timeline

As those present in regular video players (Figure 2), our overview timeline indicates the length of the lecture and the current lecture head position to allow random navigation in time. In addition however, our overview timeline (Figure 10a) also displays blackboard edits' position with respect to video duration along the length the edit took to be made, giving students an idea of the way the lecture develops and where in time new material will be written and explained.

The overview timeline makes it easy to directly skipping sections without new content; and during normal video playback students can also have an idea of the proximity of the next blackboard edit and its expected duration.

3.1.2 Visual Timeline

Yet more prominent in our tool is the *visual timeline* where the result of our lecture summarization is presented as *vignettes* in a completely illustrative way. With this tool we provide students with a quick way to *skim* throughout recordings allowing them to recognize the contents of a lecture before even playing back the video.

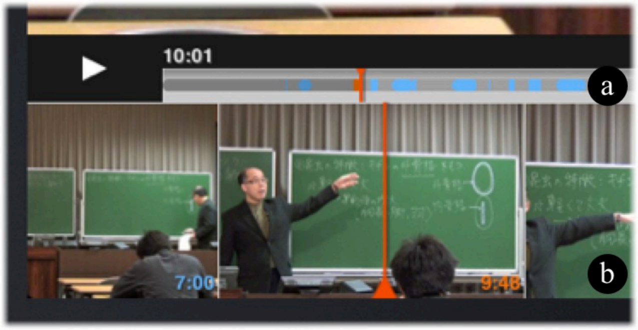

Figure 10: Close-up of the overview (a) and visual (b) timeline

Vignettes consist of relevant video frames highlighting blackboard edits'. Such frames are modified to make edits more recognizable:

- Each region of interest corresponding to a blackboard edit is extracted from the video frames. The source frame is zoomed and cropped as to isolate newly written content from the rest of the scene. This vignette is obtained from the source recording at *thumbnail time* (as described in 2.6) to ensure non-obstructed views of the region.
- Vignettes are sequentially presented in the timeline. Clicking on a particular vignette will take students to the section of the video (*creation time*) where the corresponding blackboard edit took place.

3.2 Spatial Navigation

Because our summarization analysis precisely describes when and where blackboard edits happen, we try to provide an additional way of discovering lecture recordings by revealing interactive navigation zones on the video. This *spatial navigation* allows learners to explore recorded lectures by directly touching the blackboard in the video.

Spatial navigation works as follows:

- For each detected region of interest we create a corresponding *highlight frame* hovering the video. Initially all highlight frames are hidden for regular video regular playback.
- When users touch a zone of the video where hidden highlight frames are present they become visible and all other zones of the video get dimmed (Figure 11a). Also in response to touches the visual timeline hides all non-pertinent blackboard events, narrowing selection only to those related to touched or spatially close blackboard edits (Figure 11b). If users touch a zone where nothing is present then all highlight frames are made visible at once to give the user an idea of all the "touchable" zones on the blackboard.
- Only once highlight frames are made visible by a first touch they can be touched a second time to jump to the corresponding recording section. These two touches are necessary to avoid accidental touches from disrupting normal lecture viewing. Once navigation is confirmed all highlight frames are hidden again to clear the video view and resume playback.

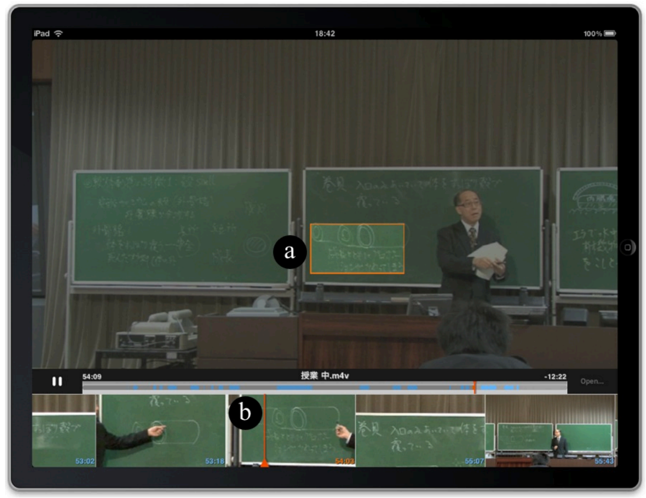

Figure 11: Spatial navigation. Touching highlight frames (a) takes users to the corresponding video sections (b)

Also inversely when using any of the two timelines to navigate the video (as described in 3.1.1 and 3.1.2) the corresponding highlight frame is temporarily shown to draw student attention to the relevant zone of the blackboard where new content is about to be written. Equally important, this quick video zone highlight is used to entice users to touch the video and discover spatial navigation functionality themselves.

3.3 Navigation Tool Remarks

As vignettes are extracted from the original video, there is no need to embed images to the XML file or to distribute them separately. All content is obtained directly for the recording at playback time, thus saving bandwidth and storage space. Even though the mobile device is responsible for extracting vignettes no major processing power is needed, and because the video file is cached locally, disk access is very fast and no noticeable delays or slowdowns can be perceived. Moreover during playback and navigation processor usage is very low and similar to that of a general video player.

Spatial navigation only works for blackboard content created during the lecture. For obvious reasons content already present before recording started is not navigable as there is no corresponding video sections to refer students to.

Our visualization tool works with iPad devices but nothing prevents third parties from porting it to other desktop or mobile platforms. As the work for analysis and summarization is done only once by the lecturer, and the output XML file is independent from the target visualization tool, the only work required would be to implement a video player capable of displaying the XML summarization results. In other words half of the work is already done and summarization results can be shared among all platforms and devices.

4. EXPERIMENTAL RESULTS

We analyzed a set of four representative blackboard-based recorded lectures. All recordings were over 40 minutes of duration (a typical university lecture) and we carefully chose videos from different sources, resolutions and aspect ratios with a mid-range 3GHz dual core configuration.

Table 1: Experimental Summarization Results

	Resolution / Aspect Ratio	Duration / Processing Time	Keyframes / Summarization Cues / Errors
a	640x360 / 16:9	1:06' / 3'42" (**18x**)	153 / **32 / 1**
b	480x360 / 4:3	0:50' / 3'01" (**17x**)	93 / **26 / 1**
c	480x360 / 4:3	0:41' / 2'21" (**17x**)	60 / **15 / 0**
d	**1280x720** / 16:9	0:56' / 9'57" (**6x**)	122 / **26 / 2**

Remarkable results:

- Analysis proved to be resistant not only to sporadic camera movements (video *a*) but also to constantly moving videos (videos *b* and *c* have been recorded by a cameraman). Only video *d* was recorded completely unmanned and had no camera movements.
- Summarization not only works with videos of distinct resolutions and aspect ratios but the summarization outputs were equally good. Mobile-friendly videos with lower resolutions were processed over 17 times faster than the playback time while for the high definition recording (video *d*), even though the number of pixels is 2 to 3 times higher, we still achieve good performance.
- Analysis outputs between 22 and 30 blackboard cues per hour. This reflects the summarizing character of the tool where a few hundred keyframes are chosen from thousand of source frames to finally output a reduced set of significant navigation features. Figure 12 illustrates the results for videos *a*, *b* and *c*.
- From 99 detected summarization cues only 4, or about 4% of them were errors (non blackboard edits). Two of these errors, illustrated in Figure 12, were the result of sharp objects being uncovered by a student lowering his head (*e1*) or camera panning (*e2*).

While not in production, our tools have been presented to a select number of students and lecturers for feedback and preliminary testing. In all cases the first user reflex was to browse the visual timeline and use the vignettes to explore the video just to be pleasantly surprised with unexpected spatial navigation possibilities. In general terms, interest and response has been hugely positive and users were able to discover all the tools' functionalities without the need of explanations and within the very first minutes.

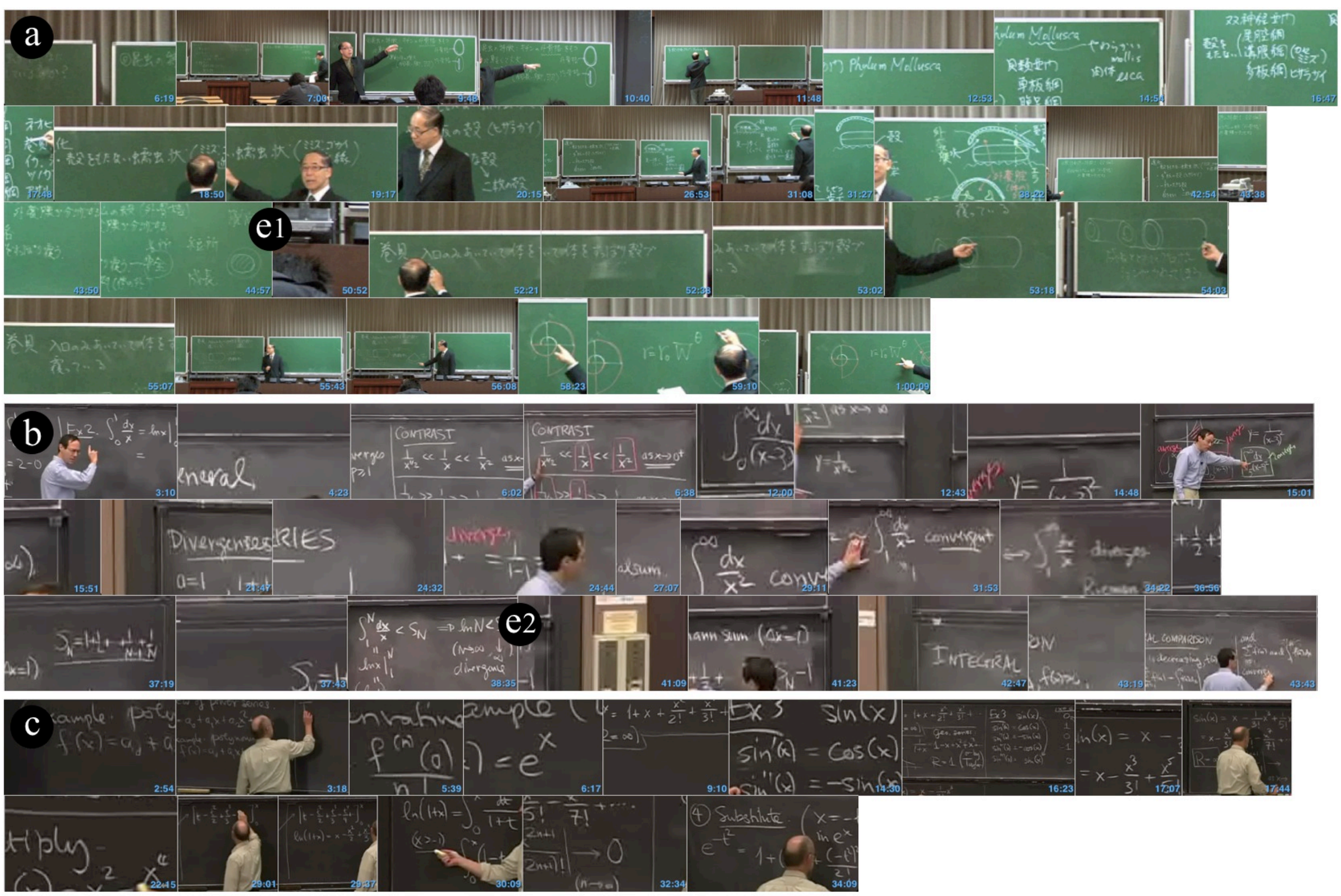

Figure 12: Summarization results as presented by our visualization tool

5. CONCLUSIONS

In this work we have presented an efficient and fully automated blackboard-based lecture summarization and analysis tool. Our analysis tool is able to quickly summarize seemingly similar hours-long lectures into a succinct set of visually distinct navigation cues with high accuracy.

Summarization can be made for new or existing videos, being them unmanned recordings or not, from any video source and with raw or edited content.

Our tool has performed very well with recordings from different instructors independently of their teaching style and classrooms layouts. Our tool offers great flexibility and no specialized recording equipment or crew is required. All ideal characteristics for lecturers and institutions with limited resources.

Analysis results have been presented with a simple yet innovative iPad mobile visualization tool. Recorded lecture viewing is enhanced with two-way navigation using overview and visual timelines as well as intuitive spatial navigation.

Both tools coupled together provide an enriched lecture viewing solution to give an answer to video inherent media navigation shortcomings. Recorded lectures become non-linear media and gain in interactivity. Video feels less of an “improvised” learning media and more in par with the features of electronic text and multimedia learning material.

In general we believe that to profoundly enhance educational videos, research limited to enhancing the video qualities of lectures will not be sufficient and contents description and structure along with a specially tailored viewing environment are keys to entice students.

5.1 Further Research Perspectives

Although the present work is centered on blackboard content, we are working on expanding the analysis tool to other media such as slides-based lectures. Another increasingly popular kind of lectures we are very interested in is *screencast* lectures. These low-cost and mostly online lectures are produced by lectures, and enthusiasts alike, and consist of computer screen recordings accompanied with walk-through audio dubbed explanations.

Further on we also intend to make our tools openly available for general usage, real-world deployment and/or portage to other desktop and mobile platforms.

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Connectedness in Practice-Based Education: The Why, Who, What

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Abstract
This paper presents the analysis of a diary study conducted to understand the role of connectedness and how it reflects on the learning of university students in a mobile setting. The study was carried out among teacher trainees while they were involved in teaching practice. A number of challenges for supporting connectedness through means of technology have been identified and they are discussed with respect to the potential of social networking tools.

Keywords
Connectedness; awareness networks; mobile students; social networking applications; practice-based teacher education.

1. INTRODUCTION
This paper elaborates on the notion of connectedness and illustrates its role for emotional and social well-being and as a precondition for learning and reflection. Rather than drawing attention to aspects inherent in formal learning processes, this article addresses the feeling of connectedness as an aspect that might reflect on specific learning experiences. This argument is grounded in the nature of the setting discussed. In the case study presented, the students move to a new location as a part of their studies. During the time spent at this new place, it is important for them to collaborate with their peers, to be in touch with friends and families and to establish and keep connections with people they meet at the new location. The case study presented raises interesting issues related to the feeling of connectedness, how it may reflect on the students' emotional and social well-being, as well as on the collaborative reflection involved in their learning projects. Moreover, the participants' need to travel to a new location, to undertake their training program, foregrounds aspects of mobility inherent in their practices. What becomes relevant here is to understand how the orchestrations of people involved and tools used might change at the new site and why they are important both for learning and emotional well-being.

There are many definitions of connectedness. Our work draws on Nardi's notion (Nardi 2005) characterizing affinity as the feeling of connectedness achieved through activities of social bonding, such as eating, drinking together and sharing experiences in common spaces.

Technologies that focus on social interactions, such as awareness system, have been proposed as means to bring communities together (Ijsselsteijn et al. 2003) and (Kuwabara et al. 2002). Nardi (2005), for instance, argues for addressing not only how to support communication, but also on how to establish a feeling of connection with others. This feeling is important for sustained interaction over time and it needs to be nurtured. The feeling of being connected has been identified as a critical factor within communities for sustaining membership and belonging (IJsselsteijn et al. 2003) and (Rettie 2003). Feeling disconnected not only reflects on social well-being, but also on the process of sharing experiences and reflection that are critical to the learning process. Connectedness is central for learners' social well-being, and it is important for them to feel connected with other learners, to create the feeling of belonging and trust, and to promote the community as a supportive environment for learning.

While connectedness among family members and friends is relevant in an educational setting, further research is necessary to understand the specific elements of connectedness in a learning situation (Morken et al. 2007). This is particularly important when the students move from one environment to another as a part of their learning process. Three different categories of connectedness in the domain of teacher education have been identified (Hug & Möller 2005) and they include both formal and informal aspects of learning. They are: i) intellectual connectedness which relates to sharing and developing ideas about the subject studied, ii) emotional connectedness which relates to the feeling of "not being alone" and supporting one another and iii) pedagogical connectedness which allows examining beliefs about the subject. In other words, these categories suggest that a social context for learning can be facilitated by the possibility to share information and learning resources, as well as emotions and experiences (Smith & Peterson 2007).

In this paper, we present a diary study conducted to understand the notion of connectedness and how that may affect learning and reflection among teacher trainees when they are out in practice. An analysis of the diary study and a reflection upon the design of social tools to support connectedness and learning are presented. The paper is organized as follows: Section 2 describes the case and the diary study; Section 3 provides the analysis of the diary study; Section 4 discusses the challenges in supporting connectedness; Section 5 provides a reflection on the design of social tools and Section 6 concludes the paper.

2. CASE DESCRIPTION: PRACTICE-BASED TEACHER EDUCATION

For the case reported in this paper, we have studied a one-year postgraduate Teacher Education Program, referred to as PPU. This program, training teachers for lower and upper secondary school and for adult education (Haugaløkken & Ramberg 2006), encompasses classroom practice, theory and group-based work. For this course, our university cooperates with 30 schools that are grouped to create partnerships. One partnership includes 5 schools offering teaching practice to approximately 30 students. Students of a partnership are generally evenly distributed among the five schools of their partnership. A number of mechanisms and strategies are adopted to ensure that students are constantly helped in their learning process and to promote reflection. For instance, regular meetings with professional mentors, support groups, and plenary meetings are often organized during the practice period.

During the course, each student has 12 to 14 weeks of practice, with a schedule of approximately 350 hours: 100 hours for teaching, 50 hours of guidance, 100 hours of preparation and follow-up work and 100 hours of other activities. The practice period is divided into 2 parts, with about 6 weeks in the autumn and a slightly longer period in the spring. Each partnership is held responsible for assigning students to their respective teaching practice schools and for following up each student individually. Within each partnership, the students are assigned to base groups of 3-4 members. These groups have a dual purpose: a) an arena for sharing information and discussing; b) a peer-group nurturing and provide a sense of social belonging. When our study was performed, the groups were to define and realize a small Action Research project, in order to try out, through practice, a chosen pedagogical method or tool. Students were individually responsible to implement the project in their teaching during the practice period, but were responsible, as a group, for a final report and presentation.

The case reported in this paper is part of an effort to understand how the distribution of students in practice schools impacts on their work and reflection. The long-term goal is to design mobile technologies supporting practice-based education. In particular, this study focuses on connectedness among students and how it reflects on the learning context. The data have been collected through the use of diaries participants were asked to self-document (Carter & Mankoff 2005).

The diaries were distributed to 4 students who had voluntarily agreed to participate in the study. The data were collected by a researcher external to the course, and introduced to the students by the main person responsible for the partnership. The diaries were collected electronically for a period of 7 consecutive weeks in the Spring semester, during the placement of students in their practice schools. None of the participants were co-located with their base group. One of the students was the only one from PPU students in the practice school.

The diaries were organized into two main blocks: the first one on the feeling of connectedness and the second on how this reflected on cooperation. The questions in the diary were informed by the types of intellectual, pedagogical and social connectedness introduced in the previous section (Hug et al., 2005).

In the first group of questions, students were explicitly asked if there had been moments during the training program they had felt disconnected from actors who might have been important for the learning context. This included their base group, their partnership, other students in the same practice school, teachers at the practice school and teachers from PPU. They were also asked if they thought their location had hindered the possibility to gain awareness on the progress of their group work and of the context of work of the other group members. In addition, they were asked if their location hindered them to feel close to their peers and to establish a favorable social environment and to learn from others about teaching and learning, drawing on experiences during the practice period. Moreover, they were explicitly asked whether there had been anything specific they would have liked to discuss with others during the practice. The final question of the group was related to the tools they used to stay in touch with people.

The second group of questions was concerned with (a) how they perceived their location in a practice school different from the one of their base group, (b) how this had reflected on cooperation. The specific focus was drawn on sharing experience, preparation of the document and the presentation the group was to deliver and sharing and reflecting on experiences with other people who were perceived as relevant to the project.

3. ANALYSIS: WHY, WHO, WHAT

In this section, we discuss a number of needs and concerns related to the feeling of connectedness (why), whom the students need to be connected to in order to satisfy these needs (who), and finally what awareness information better reflects these needs (what).

3.1 Why

We have identified four reasons that indicate why feeling connected is important. They are emotional well-being, social well-being, reflection and cooperative work. These reasons support the different categories of connectedness proposed by (Hug & Möller 2005). The emotional and social well-being entails the personal aspect of connectedness while reflection and cooperative work reflect the intellectual and pedagogic connectedness. In our analysis of the case, the students move from their permanent environment to a new environment where they may not know many people. These are young people who belong to multiple communities (e.g. peer learners and teachers) and who have been thrown into a new set of communities. The participants expressed the feeling of loneliness in the new environment and their desire not to feel alone. Their feelings of connectedness were expressed in terms of concepts such as not feeling alone and feeling secure and confident. The emphasis put on these feelings reveals their need for feeling connected with others for their emotional well-being.

The concern for social well-being was expressed in several ways. One of the students explained, for instance, that she was afraid there might not be anyone to have lunch with at the practice school. As suggested elsewhere (Nardi, 2005), such social activities can facilitate social bonding and the feeling of connectedness. In their new environment, the students felt the need for creating social bonds and to experience the feeling of social belonging. They needed to be able to discuss things that were not just related to their teaching practice, but also of a social nature. Social relationships and friendship were regarded as important to them. Not only was it important to be able to feel connected to the other teacher trainees at the same school, but also to the teachers at the school and to feel welcomed there rather than as intruders.

The students' need for reflection was not fulfilled by the fact that they were geographically disconnected from their peers and their teachers at PPU. The geographical distribution and their busy schedules did not allow them much time to arrange meetings. In addition to this, the students also felt that there was very little opportunity to discuss their experiences with the students that were co-located, since they all had to juggle with different time schedules, and did not necessarily have their free periods together. The fifth week of the eight-week practice period was the spring semester mid-term break for the school. One of the students reported that during that week, they had more time to discuss and reflect about the teaching practice and methods with the other students in the school.

The students expressed their need for discussing their teaching experiences in general as well as the highlights. As one student expressed it, they missed the *"interesting conversations where little things become clearer"* and they did not feel connected with their peers well enough to call or email them about a trivial thing. However, if they had been co-located, they would have had such discussions more frequently and it would have been easier to initiate discussions. Discussions and reflection about the teaching practice and incidents that happen in the classrooms may be of a situated nature. It would have been ideal for the students to be able to discuss them soon after they happen or in that particular environment. Whereas when they meet with their group at a later time, some of the minor points that they may have desired to discuss at the school receive less precedence.

The students needed to collaborate with the members of their base group on an assignment due shortly after the practice period. While most of the focus on supporting connectedness among people has been on providing coordination support for cooperative work, our students pointed out that there are other reasons for feeling connected to collaborate successfully. In the beginning of the practice period, most students did not feel that the lack of contact with their group impacted on their assignment. Some of the students indicated that they had accepted the fact that they will be scattered across different practice schools and therefore had planned their work accordingly, i.e. distributed the work among the members such that they could work independent of each other. However, as the deadline for the submission of the assignment approached, they felt the need for more contact with their group for a number of reasons. They wished to know how the others were doing and how far they had managed to come. Most importantly they felt that the lack of connectedness slowed the progress of the report and they felt that if they were co-located, the increased connectedness could be a support. One student reported that the assignment was given a low priority because it was difficult to arrange meetings with the other students. This is an indication that in addition to supporting the coordination of the work, connectedness also played a role in motivating the students as individuals as well as supporting the motivation of one another. An interesting point from one student, reported during the fifth week, worth mentioning is that although the assignment work was progressing slowly, she wrote, *"at the same time, I'm not fed up of the assignment work which I might have been if we were together all the time and were reminded that we should have done this or that"*. This highlights the fact that while the feeling of connectedness was important for motivating one another, there is a need to be able to manage the level of contact or the type of information that is exchanged. It is important for the student to be able to choose the optimum level of support so that the students can manage their connections and are not overloaded with information about and from others.

The need for more connectedness for cooperative work was clear from the students' diaries. However, it was interesting to note how they adapted to the situation. On the rare occasions when the students met face-to-face with the members of their group, they planned the work to be able to do the work independently. They also reported that when they met, they were very focused on the assignment work. This is very positive with respect to the assignment work. However, this means that there was less time during the meetings for reflection upon their teaching experience and discussions related to the teaching practice. Here, we see a tradeoff between coordination of the cooperative work and reflection. The fact that coordination of the work took precedence over reflection could be due to several reasons. The assignment is a part of the final exam for the course and counts significantly towards the final results of the student. It had a strict deadline for submission. The students are also required to write a process document that reports on their individual learning process during the assignment as well as the group process and the group dynamics during the preparation of the assignment. The assignment was based mostly on didactics and pedagogic theory more than teaching practice; in fact one of the students reported that it was not specifically relevant to share experiences about the teaching practice since the assignment was not directly related to teaching or a concrete classroom situation. The students also reported that they usually met late in the afternoon, after a day of teaching. So, they were mostly tired and did not have the time or the motivation for interesting discussions.

While the feeling of connectedness facilitates cooperative work, the process of collaboration itself enhances the feeling of connectedness. As a part of the practice period, the teacher trainees had to take over the school while the teachers of the school attended a seminar. Planning for the takeover week provided an opportunity for increased connectedness among the teacher trainees located at the same school. The intense period of planning brought them closer and also helped them establish stronger social bonds and provided them opportunities to discuss and reflect upon their experiences. The students expressed explicitly feelings of connectedness experienced during this period and that they felt much better than at the beginning of the practice period.

One of the students reported that the lack of connectedness and not being able to have good contact with the group about the assignment was stressful. This is an example of the lack of connectedness affecting the social and emotional well-being of a student.

In an ideal model, these reasons for feeling connected represent a continuum. To a certain extent we could expect that social well-being is the condition that makes people feel they want to work together. Social well-being makes it easier to work together with other people and facilitates the coordination of the cooperative work. They create shared experiences that are the basis for common reflection which in turn can increase the feeling of connectedness. Though our data do in some way support this model, they also show that it is necessary to use it with caution. Some of our students clearly pointed out they do not need to feel socially connected to their peers, but still felt the need to trust them to be able to improve their learning experience.

The notion of trust emerges as central from our data. Not only did the students feel the need to be able to trust the other people they collaborated with, they were also concerned about trusting themselves more so than if they were co-located or better connected to their peers. The fact that they could not share their experiences and problems with the members of their group or with someone that they had a shared history of learning made some of the students feel that they had to deal with everything alone. Meyerson et al. (2006) defined this kind of trust within temporary groups as *swift trust*. In our experience, it seems to be connected to the absence of a shared history and the short life of the groups the students were part of.

3.2 Who

The students move from one place to another and as a consequence they become geographically disconnected from their main communities and connected to new ones. During their practice period, the students are geographically connected to the community of their practice school and disconnected from the members of their partnership and base groups and their teachers. The students have the challenge of creating new connections as well as maintaining their old ones and adapting to the different needs and requirements for participating in the different communities. Here, the notion of awareness networks may be used (Souza & Redmiles 2007). An awareness network defines the network of actors whose actions need to be monitored and those to whom one needs to make one's own actions visible.

Our students have to maintain an awareness network of the different communities they are connected to, e.g. other students and teachers, where the type and level of awareness that is needed is different for the different communities. One of the communities that these students had to maintain good connections with was their base group of students with whom they had to work on their assignment. They often expressed the need for discussions with someone they knew well from before and had the same background as them. The need for connections with the base group was not only for cooperative work, but also for reflection and social well-being. A certain affinity was expressed for the members of the base group, e.g. one student mentioned that she "*missed someone to argue with*" and another student expressed her anxiety over eating lunch alone. The students also felt the need to connect with the other students from their university at the practice school and expressed their disappointment when this was not always possible. In particular, each student was paired up with another student for the teaching practice and there seemed to be good connections between the pair of students. The students were often disappointed when the partner was busy or away when they felt a need for discussions.

During the practice period, the students were not intended to have daily contact with the PPU teachers, but with their coordinator or supervisor at the school. From the diaries, we identified that the needs for connection with the teachers at PPU were mixed. One of the students did not feel the need for a connection with them at all. The other students felt the need for a connection for clarification of various queries that may arise during the practice, for advice and sometimes to clarify the role of the coordinator at the school. For example, one student expressed it as *"it would be good to talk to a grown up person such as a PPU teacher"*. In particular, when one of the students had a conflict with the coordinator at the school, there was a clear need for a connection with the PPU teachers. A particular need for connections with the didactics teacher was expressed.

The connection felt by the students with the teachers of the practice school varied. Some felt that there was sufficient connection. Others felt the need to receive feedback from the teachers and this was important for their confidence and the improvement of their teaching practice. Here as well, the students expressed the need to connect to the teachers at the school who taught the same subject as them.

We define a community as a *loosely coupled ensemble of people that interact in some way*. Figure 1 shows the communities that exist a-priori and are defined, e.g. such as PPU teachers and students; but also communities that are not defined or that are unknown to them a-priori and for which the students expressed the need to connect with. They expressed a desire to connect to other teacher trainees who had conducted their teaching practice at the same school to discuss about the school and their experiences. They also wanted to connect to other teachers, either at the same school or any other school, who taught the same subjects as them. They felt that their need for discussing didactics could be fulfilled by such a connection.

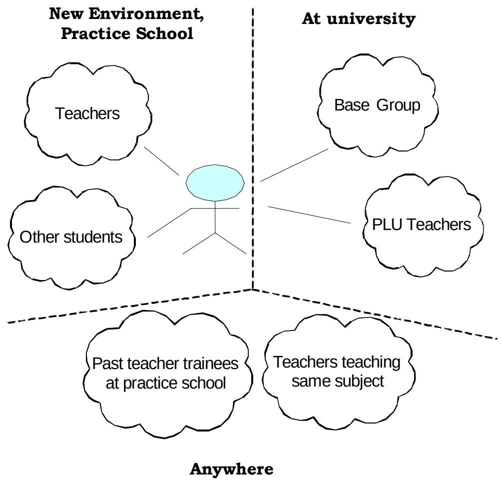

Figure 1:Communities Teacher Trainees belong to

There were also situations where there was a strong desire for a connection, but not to any specific person or a community. For example, when there was a conflict with the coordinator at the school, the student expressed the need for a connection with someone, but felt that there was no one available at that time or at the school. Thus, she was unsure who to connect to, although she clearly felt the need for a connection.

3.3 What

When we consider what types of awareness information can promote the different types of connectedness, it is important to consider why students want to be connected. As discussed earlier, the students wanted to be connected for their emotional and social well-being. They needed good discussions about the teaching practice and their experiences in addition to information related to the coordination of the cooperative work. They also needed to discuss didactics of their subject and sometimes advice from the PPU teachers.

In relation to cooperative work, it is important to point out that the type of information that we are interested in is not the awareness that is needed to coordinate cooperative activities, but rather awareness about others that might make one feels interested to start collaborating. This might or might not be the same. Nardi emphasizes that before any communication can take place, people must gain the attention of the person(s) they wish to communicate with (Nardi 2005). Part of gaining the attention of another person is also becoming aware of their availability or negotiating their availability. One of the students discovered another student at her school that she could connect to and discuss about the teaching practice only during the fifth week. She expressed her irritation that no one at the practice school had bothered to introduce them. This example shows that in many situations, the students are unable to have a clear overview of the others in their community and their availability.

From our data it is also important to point out that the needs of students evolve with time. It is therefore necessary to distinguish between the need to create the feeling of connectedness and nurturing this feeling, particularly under changing circumstances that might jeopardize it. In the case of the teacher trainees, this is clearly evident at the beginning of the practice period when students get into a new community of practice, the one of the practice school, they need to feel they belong to this community. At the same time, being physically away from their peers, they might feel disconnected from them. This might have negative consequences on the learning process as this disconnection hinders the possibility for experience sharing and reflection. As discussed earlier, coordination of the cooperative work had taken precedence over reflection and, as some students put it, *"discussions about all sorts of things"* and *"the good discussions"* didn't take place. One of the problems experienced by the teacher trainees was that they found it difficult to create new connections. This was due to a number of reasons such as the lack of time and the scheduling of the time tables for the different students. One student expressed that the teaching practice is not designed to be a social activity or to facilitate a social environment. Another student expressed having a bad conscience as she had no time for socializing. During the eight weeks of practice, the students had limited opportunity to create new connections and before they could create new connections or nurture the connections that they may have managed to create, the practice period was over. Towards the end of the practice period, some of the students switched to a "don't care" mood about the social connections with the teachers at the school or the other students in the school. The notion of nurturing existing connections is important and effort is required to maintain these connections. Similarly, unless these connections are nurtured, they could decrease over time. This is in line with the literature; e.g. Nardi and Whittaker describe the notion of a "communication zone" where a zone is a potential for communication between two people and these zones degrade over time if they are not managed (Nardi & Whittaker 2002). The effort that is required to maintain the connections with existing communities, while they are necessary for the students' well-being, also drains their focus and attention from the new environment and leaves them less time for their connections within the new environment. This is also important for their well-being and social belonging.

4. DISCUSSION

In this section we discuss a number of challenges that hindered the students' feeling of connectedness.

Threshold for initiating a connection. As it stems from the diary analysis, the students felt uncomfortable with contacting via email or telephone group members they did not know well enough. For instance, the participants often engaged in after-class discussions to comment what had just been learned during a class. At the same time, though, they hesitated to establish a contact with their peers when they were not physically present. This aspect has also been emphasized in a recent study of a social networking application within university students (Barkhuus & Tashiro 2010). The study describes how the use of such application facilitated peripheral friendship among students and encouraged them to initiate a contact with people they did not know well enough to call (for instance, to ask for notes of a class they had missed).

Managing connections under time constraints. As discussed in the previous section, being very busy with their teaching practices (and with commuting in one case) hindered the students' possibility to make new connections or to maintain existing ones. This issue is also related to the ephemeral life of the communities they participated in. Eight weeks of training was, in fact, experienced as a short time span and as a temporary situation; thus, towards the end of the practice period, some of the students dropped their interest and concern to make new connections.

Undefined and emergent communities. The data analyzed shows a concern to connect to people outside of the participants' known communities and awareness networks. For example, the possibility to discuss with people who had previously done their teaching practice in the same school or with other teachers of the same subject at any school. This point draws attention to the need to create awareness among various communities that may be of interest to the students, ones that may overlap with some of their communities for a new community to emerge. Moreover, it bring to light issues concerning how to establish continuities between the different, short-term groups that, year after year, participate in this training program.

5. DESIGN REFLECTIONS

In this section, we introduce a number of design reflections concerning the role technologies could play in supporting the feeling of connectedness within the student group investigated. The idea is to provide mobile, situated support wherever and whenever it might be needed, without the need to be at a particular location or to use a specific device. In so doing, we focus on the applications students already use, and we further explore the design space they offer. The diaries revealed that even if students used different supports (e.g. learning management systems and emails), the only support they adopted continuously across different locations was SMS. However, even providing a quick and mobile support, SMSs are not flexible and rich enough to tackle the diversity of situations and challenges the students have to face during their practice. More specifically, we believe that drawing on the social and technical trends of using social media and Web 2.0 applications, e.g. micro-blogging applications such as Twitter and Jaiku, can prove relevant for the particular setting and the challenges discussed. The reason is to be found in the nature of the study presented here, its focus on the informal interactions among students and on how engaging in them can reflect on their emotional well-being, reflection and learning. Our initial idea for design is to look into the possibilities offered by the technologies students already use. In so doing, we expect to avoid problems concerning the introduction and appropriation of new technologies into the trainees' daily lives and learning practices.

People use social media for different social purposes, e.g. "keeping in touch with friends and colleagues, raising visibility of interesting things, gathering useful information, seeking help and opinions and releasing emotional stress" (Zhao & Rosson 2009, p.245). As noted elsewhere (Smith & Peterson 2007; Ellison et al. 2009; Barkhuus & Tashiro 2010; Selwyn 2007; Lundin et al. 2010; Skeels & Grudin 2009), the growing interest and engagement of students and teenagers with Social Networking Sites (SNSs) and other Web 2.0 applications calls for a better understanding of the social and pedagogical implications of this phenomenon. Smith & Peterson (2007), while investigating the role of advice networks and implications for technology, point out that students' interactions through conversation when seeking for advice can improve learning performances primarily in two ways: a) by improving cognitive processes (e.g. repetition, deepening and restructuring of information), and b) by creating a favorable climate for learning (e.g. reassuring and lowering anxiety).

In the literature, there are many examples of how SNSs and Web 2.0 applications can be used to *improve learning performances and to support cognitive processes*. Lundin et al. (2010) look at the use of a Wiki among university students in order to share notes and field data in the context of a design course aiming at supporting specific practices with mobile technology (e.g. journalists and a delivery firm). More specifically, they focus on how this facilitated the possibility to discuss their work practice with other peers, and how it forced the articulation of their analytical work. Other researchers look at how sharing digital pictures could trigger discussion about teaching methods (Seppälä & Alamäki 2003) or bring attention to chemical processes in everyday life (Waycott & Kennedy 2009). Many of these examples focus on the use of one particular tool or platform to improve the learning processes. Abel et al. (2009) propose instead the use of LearnWeb2.0, an environment that integrates different Web 2.0 services (e.g. Delicious, Flickr, YouTube, Slideshare) to support learners and educators in sharing, discovering, and managing learning resources. However, this paper explores how to socially and emotionally engage learners in constructive learning experiences rather than looking at the formal aspects involved in improving learning performances and outcomes.

Creating a favorable climate for learning can be promoted by supporting not just sharing of information, but also Rhee & Lee (2009) suggest that sharing of experiences increases trust among participants, encouraging tacit knowledge creation that leads to deeper interactions. For instance, the authors suggest that broadcasting a video to friends or to the public is a way of presenting a virtual identity that may lead to forming a flash mob around a favorite artist or genre, lowering the threshold and cost of initiating interaction among people sharing the same interest. Ellison et al. (2009) differentiate between *bonding* social capital among strong ties and *bridging* social capital among weak ones. While strong ties interaction often leads to reinforcement of one current opinion; weak ties interaction has the potential to provide access to new ideas and diverse perspectives, and offering possibilities for increasing discourse (Ellison et al. 2009; Smith & Peterson 2007). Several Web 2.0 applications can serve both bonding and bridging of social capital, but research efforts have often focused on supporting interaction within only a particular group, e.g. students belonging to a course in rather stable circumstances (Seppälä & Alamäki 2003; Lundin et al. 2010; Waycott & Kennedy 2009). However, when students move to a new environment, e.g. starting university (Barkhuus & Tashiro 2010) or moving to new institutions as in our case, they have to deal with meeting new communities and keeping in contact with the ones they got disconnected from, having to maintain a different focus and interaction across different communities. Zhao and Rasson (2009) discuss a number of benefits inherent in the use of micro-blogging that are particularly relevant among distributed people. For instance, real-time updates may initiate impromptu conversations or prompting catching-up conversations. This could be an interesting solution for the cohort of people we studied, particularly when they wish to discuss about an incident in class or other teaching practices right after they have occurred. Nevertheless, aspects related to the collaborative appropriation of such technologies, and the students' familiarity with them would have to be taken into careful account.

Furthermore, there is a need to provide an overview of all the communities one participates in, to facilitate one's awareness network and to have selective views of these communities. Students should also be able to view selectively the details of the different communities and to be able to obtain aggregated views of selected communities, i.e. a student does not need to know that a peer or friend is at home and not at work unless she is going to call that friend. At the same time, feeling connected or being aware of friends' activities may contribute to social well-being. Again, there is a tension between the functional and emotional aspects. The challenge is therefore to explore the role that technology could play in supporting functional aspects of learning (i.e. the collaborative aspects involved in the type of learning discussed), but also aspects related to the students' emotional and social well-being in a new context.

There is a need to be able to manage the level of contact or the type of information that is exchanged. It is important for the student to be able to choose the optimum level of support so that they can manage their connections and are not overloaded with information about and from others.

Although the work for the group assignment was planned and coordinated, the students needed status information about their group members and awareness about their progress. This concern is particularly relevant since the short life of a group made the students more concerned about contacting peers they did not know well, e.g. via email or telephone. Skeels and Grudin (2009), looking at the use of SNSs in workplace environments suggest that emails and phone calls may bear a burden that *pull technology* (e.g. lightweight communication enabled by SNS) does not because "people choose when to look". Using applications such as Facebook "encourages more frequent contact than email does"; it provides "an easy way to say hello, just thinking of you' by poking or otherwise humorously greeting people. This issue also relates to the need to reduce the cost of initiating communication, (Kraut et al. 2002), by facilitating the possibility for chance encounters and easy access to awareness information. In a study conducted by Nardi et al. on the use of IM, they identified the importance of negotiating availability before communication takes place. They claim that there is a process outside of information exchange in which people reach out to others in a social rather than an informal way; they called this "outeraction". Hence, a social connection is established prior to an interaction (Nardi et al. 2000).

6. CONCLUSIONS AND FUTURE WORK

This paper has presented the analysis of a diary study conducted to understand the role of connectedness, and how it reflects on the learning experience of students engaged in teaching practice. The analysis has highlighted that connectedness is important for the pedagogical aspects of learning - i.e. reflection- as well as for its functional aspects - i.e. writing the group assignment. Moreover, it has shown that the feeling of connectedness played a role in the students' learning processes. Several challenges for supporting connectedness have been addressed and discussed with regard to the potential offered by social networking tools.

The role of technology in supporting connectedness and learning entails people's emotional well-being and the more functional aspects of learning. We have thus argued that the design of technology should take into consideration: 1) the intertwinement of issues related to a student's personal life and learning; 2) its use across different contexts and situations where a variety of people may be involved. We also regard as important to consider how technology could support a transition between individual and collaborative work, particularly with respect to reflection. In the future, we plan to design a number of applications for mobile technologies and social tools drawing on the findings of this work.

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Embedding Moodle into Ubiquitous Computing Environments

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Abstract

Over the past years several attempts for connecting Moodle to mobile devices have been made. The past attempts are focused on making the functions of the virtual learning environment (VLE) available on mobile devices. For this particular form of enabling access to learning the mobile device is limited to a special display type. Features of personalizing learning experiences based on the learners' mobility and their changing information needs in different contexts is typically not considered by these developments. This conceptual paper analyses the underlying concepts for a system-architecture for device adaption for mobile learning. The analysis focuses on educational and technical perspectives for system design. The results of this analysis are transferred for integrating Moodle into ubiquitous computing environments.

Keywords

Device adaptation, personalisation, ubiquitous computing, virtual learning environments

1. INTRODUCTION

Over the past years several attempts for connecting Moodle to mobile devices have been made (Yingling, 2006; Moodle4iPhones, 2010). Similar attempts can be found for commercial products (Blackboard, 2010; Giuntilabs, 2010; IMC AG, 2010) and other open source solutions (Silverio, 2008; Ghiglione, 2009). The past attempts are focused on making the functions of the virtual learning environment (VLE) available on mobile devices. For this particular form of enabling access to learning the mobile device is limited to a special display type. Features of personalizing learning experiences based on the learners' mobility and their changing information needs in and across contexts is typically not considered by these developments.

This conceptual paper analyses an IT infrastructure-architecture for integrating aspects of learner-mobility with Moodle in order to blend relevant information from the VLE with spatial learning environments that are equipped with ubiquitous computing systems (Morken & Divitini, 2005). Mobile devices can serve as sensors for context detection as well as anchors for on-going personal interaction of learners with the VLE across contexts. This architecture is applied in a set of Moodle extensions.

The rationale of the presented architecture is based on the notion that learning processes are continuous processes that take place in different environments. These environments can be virtual or spatial. From an educational viewpoint the different learning environments are not disconnected. The connectedness of virtual and spatial learning environments has been widely reflected and discussed using the term "blended learning". Until today, blending VLEs and spatial learning environments heavily rely on teacher mediation and are not well supported by the IT infrastructure.

The recent developments of mobile interfaces to VLEs illustrate the underlying problem. Although mobile devices can now be used to deliver learning resources to learners almost anywhere and anytime, the major VLEs do not enable instructors to contextualise learning activities. For example, by default it is not possible for instructors to anchor learning activities or resources to locations. If an instructor intends to utilize the VLE information during a fieldtrip, it is up to the instructor to communicate the relations between locations, learning activities, and resources.

Embedding a VLE into a ubiquitous computing environment raises another problem. By design, most VLEs have interfaces that allow a single system-user to interact through a single interface at a time. This means that every user of a VLE requires a dedicated interface that is bound to a single device. Even if a user has several devices at hand, the interfaces will represent the same learning environment rather than expanding it. Opposite to this single-user single-interface metaphor, ubiquitous computing environments typically follow a multi-user multi-interface design. This means that different system-users may share interfaces, or that they can distribute information across different interfaces.

In addition to the prominent device specific content delivery for improving the access to learning two problems areas have to be considered for *device adaptation*. The first problem is the contextualisation of learning and learning support. The second problem is the orchestration of interfaces and educational services.

The aspects delivery, contextualisation, and orchestration are important for mobile learning. By integrating them into VLE functionality eases the use of mobile learning approaches by a larger educational audience.

This paper discusses the underlying concepts of a system-architecture for device adaption for mobile learning. The analysis focuses on educational and technical perspectives for system design. The results of this analysis are transferred for integrating Moodle into a ubiquitous computing environment.

2. RESEARCH OBJECTIVE

The primary objective of the present research is to adapt technology-equipped spatial learning environments to the learning tasks of a learner or a group of learners, where the contextualised learning tasks are defined in a VLE. This special form of device adaptation is based on the observation that the different learning environments are not separated elements of the learning process. Instead, the different environments are interconnected and contribute to the same process. Constructing and managing the connections between the different learning environments with different technologies is typically left to teachers and instructors. Through a technological integration it is expected that the complexity of managing blended learning across learning environments can be reduced.

The primary objective of the present research has two subordinate technical objectives that are within the scope of this paper.

1. Extending the context-awareness of Moodle.
2. Integrating Moodle into technology-equipped spatial learning environments.

It is necessary to extend Moodle with functions that add generic context-awareness to the system, because the VLE needs to be aware of the learners' contexts in order to select and to adapt information for the spatial learning environment. Learner support in spatial learning environments requires that the entire environment is aware of *implicit* factors that define a learning setting, whereas learning activities in most contemporary VLEs are structured by the *explicit* arrangement of resources and services as well as on the *explicit* navigation of the learners through these arrangements.

On top of generic context-awareness, additional interfaces for Moodle are required for embedding the VLE into a ubiquitous computing environment. These interfaces have to reflect that the learners no longer access the VLE through a single communication channel, but through a heterogeneous infrastructure of personal and shared devices. Therefore, the VLE needs to be able to distribute information across different user-interfaces rather than just responding to a page-request from a web-browser.

3. BACKGROUND

Although the objectives appear to be primarily technology-centred, the technology requires an educational and instructional foundation. For this purpose this section emphasizes three conceptual pillars.

1. Personalisation and contextualisation
2. Orchestrating learning
3. Supporting learner-mobility

3.1 Personalisation and Contextualisation

Personalisation is increasingly important in technology-enhanced learning. However, personalised learning is not unambiguous. Two general viewpoints on personalisation can be identified. The first viewpoint defines personalised learning as individualised and tailored educational experiences (Aroyo et al., 2006). The personal dimension in this viewpoint is directed towards facilitated educational processes that are unique to a learner. The second viewpoint emphasises the personal relevancy and involvement of individuals in learning process (Verpoorten, et al., 2009). From this perspective, personalised learning refers to those processes that support learners to take responsibility and control over their learning and enable them to reflect on the learning on a meta-cognitive level.

The two perspectives on personalisation are not mutually exclusive: learner-controlled learning processes may lead to unique learning experiences and automatically adapted educational environments may support deeper learning experiences that help them to feel more responsible for their learning. However, learner-control does not promote a specific kind of educational approach, because learner-control and unique learning experiences can be provided in mass education, and fully tailored educational processes can be provided without leaving any control to the learner.

Contextualisation can be considered as a more generic form of personalisation. The concept of contextualising broadens the scope from the individual learner controlling a self-centred process to the learner in a context that includes co-influencing relations between elements within the same context (Zimmermann, Specht, & Lorenz, 2005, Zimmermann, Lorenz, & Oppermann, 2007). Contextualisation can be considered as adaptation processes that support learners to identify, create, and maintain relations between elements including themselves in and across contexts.

Device adaptation has been previously discussed largely as a special form of "adaptive presentation" (Brusilovsky, 2001). The related research (Ally, Lin, McGreal, & Woo, 2005; Bomsdorf, 2005; Elson, Reynolds, & Chapman, 2007; Hassan & Al-Sadi, 2009; Herder & van Dijk, 2002; Martín, Carro, & Rodrígez, 2006) highlights the need for adapting learning resources and services to the user interfaces of mobile devices. This type of adaptation primarily focuses on device characteristics and is combined with additional adaptive approaches for personalisation. However, device adaptation is restricted to adaptive presentation. In order to widening the scope of device adaptation the following definition is proposed.

Device adaptation describes approaches of adaptive systems that include device characteristics in their adaptation strategy.

This definition suggests another type of device adaptation besides including previously suggested approaches: *adaptive device selection*. Adaptive device selection describes approaches that identify and select devices for user interaction based on contextual parameters. This type of adaptation is of particular interest for combining mobile learning with ubiquitous computing (Specht, 2009). Figure 1 shows a multi-interface environment with personal and social interfaces.

Figure 1: Multi-interface environment with personal (front) and social interfaces (back).

3.2 Orchestrating Learning

Dillenbourg (2007) identifies three dimensions that are involved in orchestration. The first dimension is the interplay of learning activities at different social planes. The planes are bound to the social connectedness of learners on the activity level and can include the individual, collaborative, collective (class wide) activities. The second dimension is the timing of an educational script. Timing refers to the interrelation of the learning activities and the transitions from one activity to another. The last dimension is the focus on the learning process. Focus refers to emphasizing or hiding aspects of the learning objective in order to guide the students' attention. Integrating these dimensions allows teachers to manage the available environment for learning.

Orchestrating learning is closely related to educational design. According to Goodyear & Yang (2009) educational design "is largely a matter of thinking about good learning tasks (good things for learners to do) and about the physical and human resources that can help learners to succeed with such tasks." (Goodyear & Yang, 2009: p. 169) When analyzing educational designs it is required to distinguish between learning outcomes, learning activities, and learning tasks. "Learning outcomes are the durable, intended, and unintended cognitive, affective, and psychomotor consequences of the learner's activity (mental or physical)." (Goodyear & Yang, 2009: p. 169) These outcomes are the result of what the learner does. In other words, learning outcomes are the direct consequence of the activity of a learner. According to Goodyear & Yang, learning activities are based on the learner's interpretation of the requirements of learning tasks. Teachers or instructional designers typically define learning tasks.

Van Merriënboer, Clark, & de Croock (2002) structure the educational design process into four interrelated components: learning tasks, supportive information, just-in-time information, and part-task practice. Learning tasks are provided to learners in order to stimulate whole-task experiences for constructing knowledge (schema and rules). Supportive information is supportive with respect to the learning tasks. It bridges between learners' prior knowledge and the learning task. Just-in-time information refers to procedural rules of the educational design and the related information for communicating these rules to learners. Part-task practice items "are provided to learners in order to promote rule automation for selected recurrent aspects of the whole complex skill" (Van Merriënboer, Clark, & de Croock, 2002: p. 43). Educational design processes rely on aligning these components for generating coherent learning experiences that lead to higher transfer performance then designs that do not take all components into account.

While educational design is indirect to the learning situation, orchestrating learning implies also the direct management of performing learning tasks during runtime. From this viewpoint orchestrating learning includes the personalisation and the adaptation of learning tasks, because personalisation and adaptation refer to management decisions related to dynamic task arrangements in a learning environment. However, educational design and orchestrating learning go beyond defining rules for learning. Both concepts build on three pillars: learning tasks (and sub-tasks), learning environments, and procedural rules. Orchestrating learning crucially depends on the coordination of the relations between these pillars.

Koper & Specht (2008) argue that related coordination problems can be identified at different levels of complexity of the learning environment. New tools and services can enrich the learning environment in ways that meet the learning needs of lifelong learners. Furthermore, the authors emphasize the connectedness of services and roles in learner communities at the different levels.

Based on the research on educational design, orchestrating learning refers to the coordination and the alignment of four dimensions.

- The roles that are involved in the educational activities and the interplay of the different social planes (Dillenbourg, 2007).
- The learning tasks include the main learning tasks (Goodyear & Yang, 2009) supportive tasks, and part tasks (Van Merriënboer, Clark, & de Croock, 2002).
- The learning environment includes all kinds of services, knowledge resources (Koper & Specht,

2008), just-in-time and supportive information (Van Merriënboer, Clark, & de Croock, 2002), and the characteristics of the spatial learning environment.
- The rules and directives for the educational process, including the timing and the educational focus (Koper & Specht, 2008).

The typical VLE approach to orchestrating learning is to arrange the resources and services around a specific learning task. This leads to appropriate results because the VLE controls the relation of learning tasks and the related environmental elements. In other words, the environment cannot change without changing the learning task.

From the more general instructional design perspective roles, learning tasks, and the learning environment mutually influence each other within the conditions defined by the rules that guide the educational process. For example, possible learning tasks can be constrained by the presence or absence of other participants in an environment. Therefore, mechanisms for integrating a VLE into ubiquitous computing environments are required in order to reflect the mutual relationships between the elements of educational processes.

3.3 Supporting Learner-mobility

The ambient information channel (AICHE) model (Specht, 2009) is an attempt to integrate concepts of context-aware computing and the relations of different aspects of mobile learning. It allows analysing generic patterns of contextual interactions and contextual learning support. These patterns include context matching as well as context construction. The patters can be used to provide generic solutions for conflict resolution, so the rules and the directives of an instructional design can focus on relevant aspects of the educational process. Furthermore, the AICHE model helps to describe and to analyse contextual information needs of mobile learners.

The core facets of the AICHE model are information channels and physical artefacts. By abstracting information channels from their presentation modes it is possible to model the arrangement and re-arrangement of information channels depending on a learner's context. The arrangement of information channels means that a channel can be temporarily bound to physical artefacts, e.g. a TV set, a mobile phone, or a desktop computer. The underlying contextualisation pattern is based on the process of aggregation, enrichment, synchronisation, and framing of information. Aggregation refers to the collection and processing of low-level sensor data into operational information. The enrichment process connects the operational information to the related entities of a process. During the synchronisation process related (enriched) entities are identified. This process results in a matching of entities. E.g., the location of a learner is matched with the location of artefacts through related location metadata. The framing process is mostly related to feedback and the stimulation of meta-cognitive processes. This process is related to the construction of educational contexts.

The separation of devices and information channels in the AICHE model opens a new perspective on mobile learning: the mobility of learners takes place in an ecosystem of technologies. In the last decade devices and technologies were increasingly converging. The "Internet of Things" (Sarma, Brock, & Ashton, 2000) and ubiquitous computing (Weiser & Brown, 1996) slowly become part of normal life in industrial nations. An increasing number of home entertainment devices, including TV sets and digital picture frames, are already equipped with network connectivity and can integrate seamlessly into home computing networks and connect to services on the Internet. Following the AICHE model the different devices are possible endpoints for information channels. However, the setting of the different devices varies and creates specific requirements for information provisioning. These requirements go beyond the personal computing paradigm (Thacker, McCreight, Lampson, Sproull, & Boggs, 1979).

Previous research has suggested a layered system-model for contextualisation and adaptation for technology-enhanced learning support (Zimmermann, Specht, & Lorenz, 2005; Verpoorten et al., 2009). The model describes an information-processing pipeline. This pipeline is based on the input from a sensor network. The tracked data is diverted for information presentation as well as for the control processes for system adaptation. Table 1 shows the relation of the proposed layers with the related data processing functions.

Table 1: Relation between the architecture layers and data processing for context-aware and adaptive systems

Architecture layers	Data processing functions
1. Sensor layer	Data collection
2. Semantic layer	Information selection
3a. Control layer	Information arrangement
3b. Control layer	Information application
4. Indicator layer	Information presentation

For

learning categorising different approaches to mobile information technologies a simple framework is proposed that reflects the different characteristics of
This framework has two main dimensions that characterise a device: the mobility dimension and the ownership dimension. The mobility dimension distinguishes between mobile and stationary technologies. Mobile technologies are easy to transport by a single person and allow the usage while
technologies that require installation before they can being mobile. Stationary technologies refer to
be used or transported. The ownership dimension separates personal and social technologies. Personal technologies are designed for being used by a single person. E.g., mobile phones,
technologies. PDA, and personal computers are personal
information access for group interaction billboards and Social technologies allow simultaneous
public
technologies. information screens are examples of social

By connecting the two dimensions four technology clusters can be indentified (Figure 2). The first cluster is related to stationary personal technologies. This cluster is directly related to personal computing. The second cluster is the mobile personal technology cluster. This cluster groups technologies such as PDA, mobile phones, and mobile gaming devices. The third cluster integrates stationary social technologies, such as electronic billboards or interactive information walls. Finally, the fourth cluster refers to mobile social technologies. As an example of such technologies may serve portable speaker systems through which sound experiences can be shared.

		Primary device usage	
		Personal	Social
Device mobility	Stationary	Personal Computer	Smart board, public information screen
	Mobile	Mobile phone, PDA	Mobile Audio Speaker System (excl. head-phones)

Figure 2: Dimensions of mobile learning support

The framework allows focusing on the characteristics of technology use when conceptualising and analysing contextualisation of information channels. While recent developments focus primarily on personal devices the present research seeks to extend the scope to stationary social systems.

4. CONNECTING MOODLE TO SPATIAL LEARNING ENVIRONMENTS

This section describes the architecture for integrating Moodle into a ubiquitous computing environment. Figure 3 shows the different components of the presented solution in relation to the conceptual model for context-aware and adaptive systems.

The core requirement for the implementation was to avoid changes of the core application interface. This has been achieved through Moodle's plug-in interface. The rectangles in Figure 3 indicate the plug-ins, which were implemented. This approach was only violated by extending the internal function for activity tracking in order to trigger data aggregation and to control processes depending on the learners' activity. The logging function is shown as a rectangle with rounded corners. This small extension (a single line of code) automatically allows any activities using existing Moodle plug-ins to trigger personalisation and adaptation processes in external plug-ins.

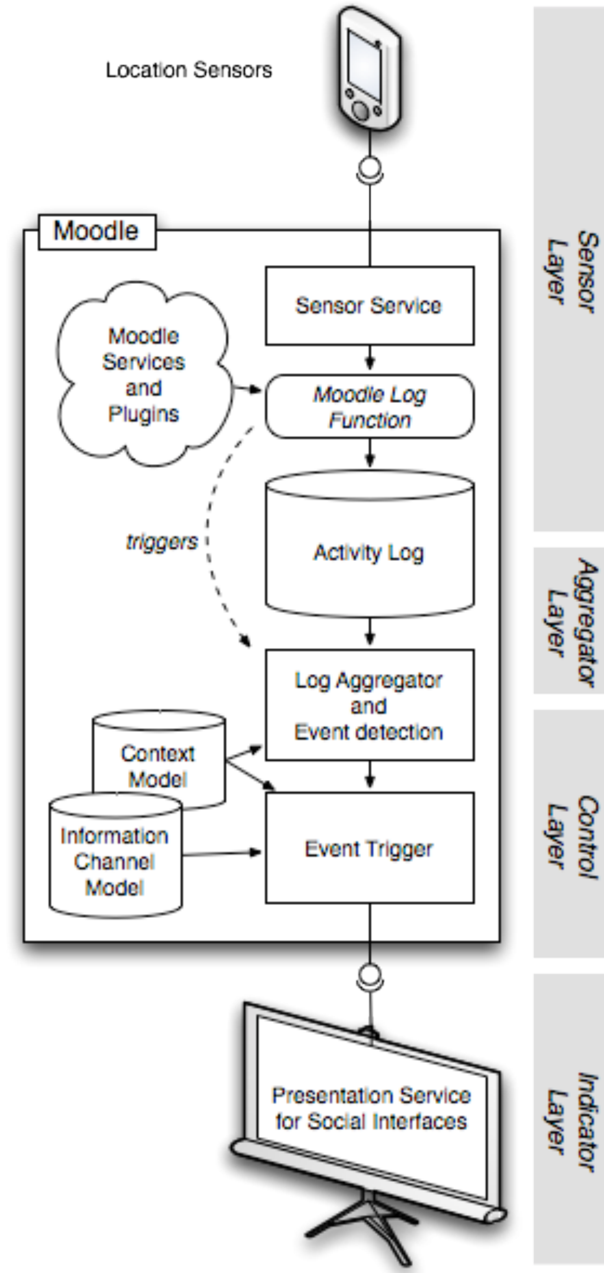

Figure 3: Component architecture and data processing schema

4.1 Data collection from external sensors

For connecting Moodle to ubiquitous computing environments the system has been analysed based on the layered system-model. The first step for contextualisation and adaptation is the data collection. This data is required for user and context modelling.

Although Moodle does not support external sensors, the system provides a central tracking component. This system component is used by all system components and extensions for activity logging. This component is typically only available to instructors for monitoring learner activities. By implementing a service interface based on the

Moodle plug-in application interface the internal tracking component is exposed to external sensor networks.

The initial use of the data collection service is to return the location of learners to the system using the geo-location data that is offered by web-browsers of recent mobile devices. This data is collected through Moodle's mobile user-interface. Together with asynchronous service calls this is the foundation for integrating location awareness into Moodle. Wireless Network triangulation capabilities that are present in an increasing number of mobile handheld devices even allows indoor location tracking where GPS signals are usually inaccurate or unavailable.

4.2 Data aggregation and information selection

The second layer of the system-model is the semantic layer. This layer defines the context model and performs data selection and data aggregation operations on the tracked sensor data. Moodle itself has no data selection functions other than exposing the raw tracking information to system administrators and course instructors. Therefore, an aggregation plug-in has been implemented for Moodle. This plug-in provides selected views on the tracked data. Each view can get accessed through named aggregators that relate to a data selection and processing function on the activity logs.

In order to provide data privacy, only authenticated system users have access to these aggregators. Furthermore, this plug-in implements social perspectives on the data. A social perspective provides learners with anonymous information about their peers. The different social perspectives are "self", "friends" (learners who are in the personal address book), "group members" (in case of group work), and "peers" (other learners who are enrolled in the same courses). The social perspectives provide basic metrics to the learners in order to relate their personal activity to the activity of their peers.

The aggregators of the semantic layer are dynamic factors of the context model that is used for adapting social interfaces in the spatial learning environment. The control layer uses the output of the aggregators for identifying the activity context of the learners, and for adapting the learning environment if necessary.

4.3 Context modelling

In addition to dynamic context factors context identification and adaptation require static reference factors. These static factors of the context model are considered partly as elements of a learning environment and partly as rules of an instructional design. Therefore, a teacher or instructor has to be able to anchor information channels to locations in the spatial learning environment. An information channel can be any resource or service (e.g., a discussion forum) that is part of a Moodle course.

Anchoring information-channels to ubiquitous computing environments requires two additional models.

1. A context model
2. An information-channel model.

The context model is shared across all courses in the Moodle instance. This model defines the name of a context, the extent of a context, and the devices that are available in that context.

The name of a context is needed so teachers and instructors can later link their information channels to the location. For example, a name of a context can be the number of a room where certain learning activities should be performed.

The extent of a context is used to identify if a learner matches the context. This defines the outer boundaries of a location, so it is possible to distinguish if a learner is present at a location. If the extent of a context refers to a parameter in a specific course, then this context is limited to a single course. Locations are normally modelled as global contexts.

The devices that are available in a context are modelled as URLs to services that can be used for sending a particular information type to a device. Additionally every URL has an indicator if it provides a personal or a social interface, and if the service is capable to integrate the same information channels for different learners.

The information channel model connects resources or services to a location. The information channel model can be defined for an entire course or bound to a single learning activity. If a resource or a particular service is anchored to a location it is no longer available to the learners as part of the normal course structure.

4.4 Controlling contextualisation

The control layer uses the dynamic context model based on the learners' tracking information, the context model, and the information-channel model for arranging the information that has to be available in the learners' context. If a new context has been identified for a learner, then the related course and, if defined, the related learning activity is activated, too. Furthermore, all information channels are selected for the active context.

The information arrangement of the control layer is implemented as a set of internal functions that are invoked by the higher order interfaces during the information application process. A learner is considered to be in a context, if the extent of the context matches the dynamic context factors of the learner. The context matching is performed on the contextual dimensions that are defined by the AICHE model.

The information application is implemented as a web-service interface that allows reading the context state of a learner from a Moodle system. The information application layer of this control process triggers the information arrangement and if this process results in any information channels for a context this service will select appropriate interfaces for each information channel and forward the channel to the external device.

4.5 Information presentation

Every context can offer a range of interfaces for presenting information channels. Each interface in a ubiquitous computing environment has to be considered as an independent information system that has special capabilities and that can be addressed through a common network infrastructure. The different capabilities of an interface are implemented as separate web-services to which the control layer can forward the information channels.

Because ubiquitous computing environments are in principal multi-user environments, the underlying web-services are responsible for integrating the information for different learners in case of shared interfaces or lock a system to a single learner in case of personal interfaces. How this integration is done depends on the type of information channel. For example, tagging channels of different learners might be integrated into a share tag cloud that can be used to discuss shared interests. In contrary, video streams on a shared screen will be cued and played sequentially.

4.6 Triggering the device adaptation process

In normal single-interface web-usage of Moodle, the activation of an adaptation processes is triggered by learners' requests to the web-server of the VLE. In these settings the adaptation process is bound to the interactions of a learner with the VLE. If a component expects external updates in this setting, then it has to check periodically for them. This so-called *pull*-approach has been implemented by a few extensions of the Moodle system, such as the implementation of a chat tool. More commonly Moodle components do not expect any changes for the interface between two interactions. The single-interface metaphor assures that the adaptation process is related to the learner activity and that the number of requests per learner is reasonable.

In multi-interface settings the *pull*-approach quickly becomes inefficient, because a learner may has several information channels connected to different devices in an environment but interacts only with one at a time. As any interaction may affect information that is on display at another interface, all active interfaces have to check periodically for updates for all connected learners. In order to avoid unnecessary network overhead, the presented architecture *pushes* updates to the connected interfaces if needed.

In order to detect updates, the service of the control layer is triggered whenever data is added to the Moodle logs. However, context tests are only performed if the added data entry influences a dynamic context factor for the learner. Consequently, updates for the related information channels are only pushed if real updates become available.

5. CONCLUSION AND FUTURE WORK

This conceptual paper analysed the underlying concepts for a system-architecture for device adaption for mobile learning. The analysis focuses on educational and technical perspectives for system design. The results of this analysis are transferred for integrating Moodle into ubiquitous computing environments.

Integrating Moodle into ubiquitous computing environments required the development of new service interfaces for the system. Nevertheless, the central user-tracking component of Moodle has been reused. This has the main benefit that this architecture allows to use other learner activities within the VLE as contextualizing factors for the adaptation process because all operations for contextualisation and adaptation are built on top of this component. Furthermore, the architecture can be easily transferred to other VLE, because most systems have similar learner-tracking components.

Given the technical scope of this study further research is needed with regard to the effect of this extended perspective on device adaptation for personalized learning and instructional design.

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Locating Mobile Learning in the Third Space

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Abstract
The paper provides a framework for mobile learning that highlights three key features characterising such learning. These features are authenticity, social interactivity and customisation. The features were suggested through their presence in two mobile learning projects, *Mobagogy*, a project in which a higher education learning community developed understanding of mobile learning and *The Bird in the Hand Project*, which explored the use of smartphones by trainee teachers and their mentors.

Keywords
mobile learning; learning communities; higher education; trainee teachers; framework

1. INTRODUCTION
Mobile devices are becoming increasingly more ubiquitous and powerful in their applications. In this article we use the definition of mobile devices provided by Cheung and Hew (2009), which refers to *"any small machines that can be carried easily in one's palm and provide computing, as well as information storage and retrieval capabilities."* (p. 153). Mobiles devices have been evolving and expanding rapidly with more features being added over the past few years and they are now seen as the 'next form of portable computer' (Johnson *et al*, 2008). They are considerably smaller and less expensive than laptops, yet have powerful multimedia, social networking, communication and geo-location (GPS) capabilities and are becoming more and more embedded, ubiquitous and networked (Johnson *et al*, 2008). As a result, mobile learning appears to offer numerous opportunities as well as challenges in higher education.

In this paper we provide a critique of mobile learning or m-learning by examining available frameworks for mobile learning and suggesting an adaptation of these frameworks that identifies distinctive features currently present in, and unique to, mobile learning. We consider m-learning from a socio-cultural perspective in our discussions. This theoretical perspective suggests that learning is affected and modified by the tools used for learning, and that the learning tools are modified by the ways that they are used for learning. Central to our position here is the notion that learning is a situated, social endeavour, facilitated and developed through interactions between people.

Two projects are discussed here to illustrate and provide a vehicle for the development of our framework for mobile learning. The first project considers the learning in a community of higher education teachers who were funded to develop their awareness, understanding and use of mobile technologies to enhance their pedagogy. The second examines the experiences of a group of trainee and newly qualified teachers who were provided with smartphones (iPhones) to use in their placement and first teaching schools. A brief description of each follows:
Mobagogy is a learning community of eight educators in an Australian university, formed to investigate how best to use mobile technologies in their own learning and teaching. The educators were primarily from teacher education, but there were also two adult educators and a communications expert in the community. Activities of this group included investigating best practice approaches by interviewing experts in the field, exploring the literature on mobile learning and then initiating and testing some mobile learning pedagogies in the context of their own higher education subjects. The community met regularly to discuss emerging issues and applications.

The Bird in the Hand Project is a UK sponsored initiative supported by the Teacher Development Agency (TDA) and aimed at Higher Education trainee teachers. It explores how a group of eight trainee teachers and their subject mentors (religious education) use a smartphone (iPhones) to support and enhance their professional practice whilst on placement in their second teaching school, and through the first year of their first teaching posts. The project uses a variety of technologies and techniques to collect data from participants including the use of audio logs and blogs generated from the device itself.

2. THE TIME/SPACE CONTINUUM
Traditional formal learning might be characterised, and indeed defined, by two constants or boundaries: *time and space*. Learning places generally occupy fixed, physical spaces which are defined by relatively impermeable boundary objects such as walls, classrooms and school buildings. Similarly, traditional learning is situated in fixed temporal slots such as teaching periods, timetables or semesters, and these are also relatively fixed and immutable (Traxler, 2009). Mobile learning promises to transcend both of these spatial and temporal restrictions and therefore abolishes *"the need to tie particular activities to particular places or particular times"* (p.7).

Various authors have noted the socio-cultural implications that mobile devices have brought about in terms of time. Previously fixed engagements or appointments can now be readily re-scheduled and fixed linear time is increasingly making way for a softer version of what some authors have termed 'socially negotiated time' in which each party to an event is able to rearrange their schedules without excessive detrimental effect to either side (Ling & Donner, 2009). If current trends continue it is reasonable to assume this will also impact significantly on what are currently fixed, synchronised modes of formal learning which are intimately tied to, and regulated by linear time. The mobile device enables learners to access learning when it is appropriate and necessary: ‘just in time’ rather than ‘just in case’.

Spatial considerations, which currently determine the physical boundaries of formal learning, are also challenged by the advent of mobile learning devices. Traditional physical spaces for learning, such as the classroom, impose many constraints on what is learned and how it is learned. Additionally they drive a delivery model of learning in which the teacher is charged with expertise and authority to disseminate knowledge and content within these spaces. Mobile learning, at least theoretically, removes many of these restrictions enabling learning to occur in a multiplicity of places, many of which will be situated in the context about which learning is occurring. The imperative to 'deliver' content is reduced as the learner is able to use the connectivity, inherent in a growing number of mobile devices, to search and locate information for themselves, when they need it.

An important spatial consideration is the notion of the *third space or third place*. The term ‘third place’ has a number of meanings, depending on the context. Generally, when talking about learning, the term refers to out-of-school learning that occurs in social contexts. The first place or institution is the place where formal learning may take place. The second place, which can be in a museum, library, or home is a site where informal learning takes place. The third place is the space that lies somewhere between these two major sites at which learning occurs. Oldenburg (2000) discusses the third place as the basis of community and social life and the space in which more creative activity can take place. Gutierrez (2008) suggests it is the social context for learning which exists at the nexus between the formal and informal. It involves the re-imagining and recreation of those other spaces to provide an opportunity for creativity, insight and action.

3. IDENTIFYING DISTINCTIVE ATTRIBUTES OF M-LEARNING

3.1 Rationale

There is an ongoing need to conceptualise mobile learning from the point of view of learners’ experiences rather than the affordances of the technology tools (Traxler, 2007). For some time now, there has been considerable interest from educators and technical developers in exploiting the unique capabilities of m-devices for learning. Yet much m-learning research has simply been driven by technical capabilities of devices (Naismith *et al*, 2004). Despite the ubiquity of m-learning devices, there has been minimal use of m-learning approaches in various education sectors:

> *“... little use has been made of these convenient tools in learning contexts, and there is little theoretical foundation to the learning environments that do use them. ... it is not yet clear that there are sound theoretical reasons for the use of mobile devices in learning.”* (Herrington *et al*., 2009, p. 1)

Furthermore, educators are generally suspicious of fads (Lee, 2009) and skeptical of unfounded claims relating to technology-mediated learning. In this emerging area of m-learning, researchers need to be mindful of this suspicion and focus on useful frameworks for using mobile technologies to enhance learning across the curriculum.

Although sophisticated pedagogical models have been proposed (Laurillard, 2007; Sharples *et al,* 2007), locating distinctive features of learning with mobile devices is a continually evolving process as the devices and associated technologies mature. What does m-learning currently look like? What are the unique features of m-learning environments? Identifying specific attributes of m-learning will provide a lens for researchers’ further analysis of pedagogical understandings, help teachers to analyse practical problems and more effective mobile learning experiences, and guide the development of and offer insights into the design of emerging mobile devices and learning materials.

3.2 Current Descriptions

M-learning is described in a number of different ways, but essentially these descriptions all consider the nexus between working with mobile devices and the occurrence of learning: the learning that occurs through the mediation of a mobile learning device (Watson & White, 2006). Numerous characteristics of m-learning have been identified in the literature. DEST (2006) suggest a 5-scale framework based on the notions of immediacy; setting; interactivity; context, and integration (see Fig. 1 below)

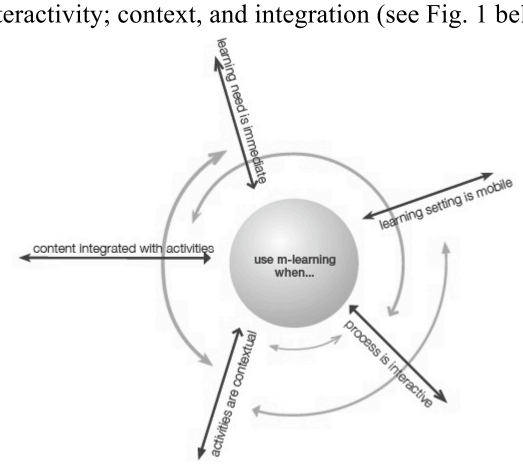

Figure 1: from DEST, 2006, p.3.

Like most frameworks, they emphasise flexibility and ‘in-situ’ learning, the facilitation of collaborative learning and better feedback (especially if remote locations). Koole's (2009) FRAME model takes into consideration both technical characteristics of mobile devices as well as social and personal learning processes (see Fig. 2 below). They emphasise the 'DLS intersection' (device-learning-social) in their discussion, and refer especially to enhanced collaboration, access to information and deeper contextualisation of learning. Learners using mobile devices can interact with instructors, course materials, as well as their physical and virtual environments.

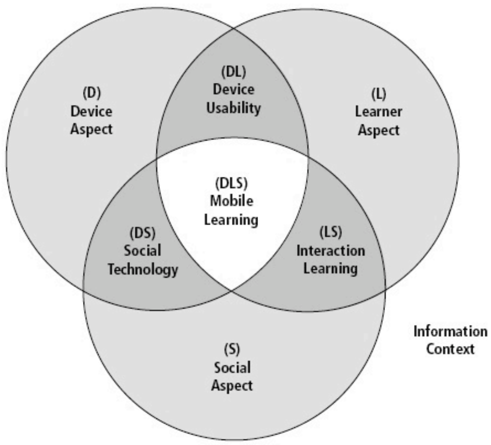

Figure 2: from Koole, 2009, p. 27

Dauaher *et al* (2009) propose a framework for evaluating m-learning based on three key principles: engagement, presence and flexibility (see Fig. 3 below). 'Presence' refers to the *"simultaneous awareness and locatedness of self and others ... encompassing the emotional element of being human"* (p. 26). They breakdown 'presence' into 3 sub-group 'interaction types': cognitive (student-content), social (peer); teaching (student-teacher):

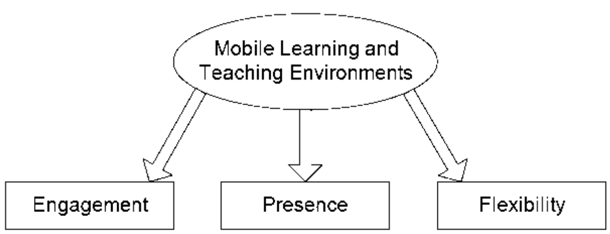

Figure 3: from Dauaher *et al.*, 2009, p.23

Traxler identifies mobile learning as moving away from the formal learning that distinguishes traditional modes of learning. He describes mobile learning as 'noisy' and problematic and featuring three essential features or elements, which include the personal, contextual and situated (Traxler, 2009, p.30). For Traxler it is not simply a matter of identifying clear gaps between traditional learning and mobile learning to frame the discourse. Rather he is concerned to differentiate between existing notions of e-learning, which he terms 'tethered learning' and m-learning, which he terms 'untethered'.

Many other authors have attempted to summarise key characteristics of m-learning. For example, Klopfer *et al* (2002) identified 5 features: portability, social interactivity, context sensitivity, connectivity and individuality. Similarly, Geddes (2004) emphasised access, context, collaboration and appeal. Kukulska-Hulme *et al.* (2009) delineated mobile learning in terms of task initiation and structuring (or task mediation). Finally, Pachler, Cook and Bachmair (2010), analysed the interrelationship of learners with the structures, agency and practices of what the authors call the *"mobile complex"* (p.1).

Common themes in these frameworks include portability of device and mobility of learner; the importance of agency over devices; interactivity; and individuality. While acknowledging that these are important themes characterising mobile learning, we have developed a model of mobile learning with features that were apparent in our projects. This model or framework incorporates three central features: authenticity; social interactivity and customization.

4. PROPOSED FRAMEWORK

In this section we attempt to capture the essence of what mobile learning currently 'looks like', working within our previously discussed conception of 'time and space'. Our proposed framework is informed by activities from *Mobagogy,* a University community of learning, and *Bird in the Hand*, a mixed case study which is situated in a variety of different spaces including a University context, a school work placement and the various informal habitus which trainee teachers frequent in between these two. Our framework is also informed by recent literature (see previous section) but attempts to more succinctly distinguish distinctive attributes of mobile learning. Hence, we highlight three inter-related features: *authenticity, social interactivity and customisation* as depicted in Fig. 4 below:

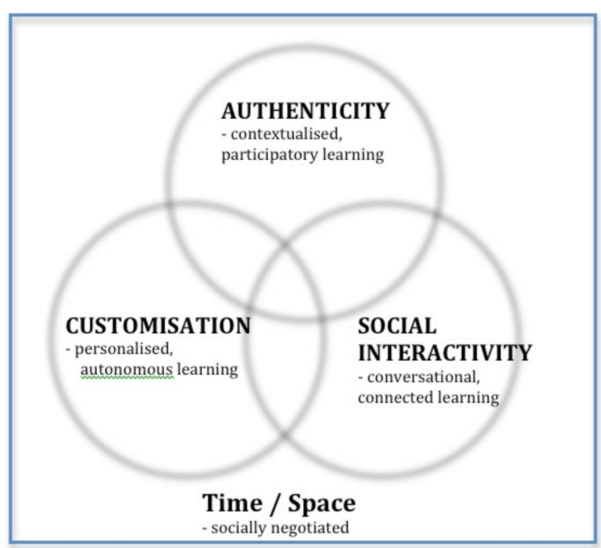

Figure 4: Framework identifying critical features of mobile learning experiences

Mobile learning experiences take place in a socially negotiated 'time and space'. with a malleable temporal dimension intertwining through these three scales (Ling & Donner, 2004). The synchronous nature of interactions, as well as the unscheduled, 'just-in-time' nature of typical m-learning experiences, create a strong sense of immediacy, spontaniety and convenience in these often incidental learning episodes.

4.1 Authenticity

There is general agreement that authentic tasks provide real world relevance and personal meaning to the learner (Radinsky *et al.,* 2001). Researchers in this field draw on situated learning theory and suggest that authentic activities can simply be defined as *"ordinary practices of the culture"* (Brown, Collins & Duguid, 1989, p.34), although ultimately, authenticity *"lies in the learner-perceived relations between the practices they are carrying out and the use value of these practices"* (Barab, Squire & Dueber, 2000, p. 38).

CTGV (1990) believe authentic tasks involve 'life-like' tasks, which require decision-making, exposure to real-world information and also allow students to generate their own problems to solve. They delineate *task, factual and process* levels of authenticity. Task authenticity refers to the extent to which tasks are realistic and offer problems encountered by real world practitioners. Factual authenticity refers to how particular details of a task (such as characters, instruments etc.) are similar to the real world, while a process level of authenticity refers to how learner practices are similar to those practices carried out in the community or 'real-world' of practice. Radinsky *et al.* (2001) used two useful models of authentic learning environments: a *simulation model and participation model*. Tasks that fit a simulation model of authenticity use the classroom as a 'practice field' (separate from the 'real community') but still provide contexts where learners can practise the kind of activities they might encounter outside of school. These tasks are valuable in that support is available from a teacher, but have limitations, as they are not an integral part of the ongoing activity of a community. Alternatively, under a *participation* model of authenticity, students participate in the actual work of a professional community, engaging directly in the target community itself. Students adopt real roles in out-of-school communities and tasks are 'ecologically' authentic (Barab *et al.,* 2000) to the degree to which learners engage in authentic practices of a community (Lave & Wenger, 1991).

Mobile learning is inherently situated and dynamic. Learning episodes typically involve high degrees of 'task and process authenticity' (CTGV, 1990)as learners participate in rich, contextual tasks (setting, characters, tools), involving 'real-life' practices. Learners can be in these rich contexts with or through their mobile devices as these spaces can be physical or virtual (or a convergence of both). The deeper contextualisation of tasks in these spaces can be supported by geolocation and data capture facilities.

An example of factual authenticity was one in which student teachers in the Mobagogy project used their mobile devices to capture puzzle resources from the classroom so that they could develop similar puzzles for their own use. Trainee teachers in the Bird in the Hand project contacted their mentors through their mobile devices to gain instant support in their learning.

4.2 Social Interactivity

Mobile learners often enjoy a high degree of *social interactivity* as they make rich connections to other people and resources. This high level of networking creates shared, collaborative environments, typically involving rich exchanges of 'just-in-existence' content and information. Mobile learners communicate multi-modally with peers, teachers and other experts, and exchange information in their *phonespace* – a *"temporally, spatially fragmented network of friends and colleagues they have constructed for themselves"* (Traxler, 2010, p11). This rich networking creates dynamic, collaborative environments, typically involving two-way sharing of 'just-in-existence' content. The spontaneity of these communications and the currency of exchanged data is made possible by the accessibility and expectation of users being reachable at all points in time.

Mobile learning is inherently social, characterised by open, global conversations amongst learners, 'at and through' their devices. Recent pedagogical frameworks foreground the importance of these conversations in teaching and learning (eg. Laurillard, 2007; Sharples *et al*., 2007), building on well-accepted Vygotskian social theories of learning. These shared conversational spaces are conducive to timely, personally tailored feedback from instructors as well as rich peer interactions (e.g. multi-user mobile gaming environments). Another feature of these spaces is the multi-modal nature of communications. Mobile learners have the ability to instantly publish, make observations and reflections, and communicate using new media.

These elements were particularly noticeable in the first data sets collected from trainee teachers in the UK study, who used their devices extensively to reflect upon the development of their professional identity using the mobile device as an instant voice recorder which they then used to e-mail the recordings to their mentors. In the Mobagogy project, teacher educators encouraged their students to send text messages to each other about their ambitions and goals for the following year when they would be teachers. These acted as a springboard for further conversations about features of good teachers.

Sharing data files is another feature of these networked interactions. Learners consume, produce and exchange an array of 'content', sharing information and artefacts across time and place. The scale of networked services such as Twitter and 'apps' such as *Air Sharing* and *iFiles* enable unheralded levels of sharing and inquiry. Exchanged files are often 'just-in-existence', enhancing the immediacy of the mobile learning experience. In the UK study the sharing and transfer of files between the various places of work and home which form the trainees' habitus was prioritised by the funding body (TDA) although early findings suggests this is not as straightforward or unproblematic as was expected and is hindered by existing technical barriers such as firewalls and concerns about virus protection.

4.3 Customisation

M-learning experiences are typically *customised* at both a tool and activity level. Users enjoy a sense of intimacy with their personal devices and the flexible, autonomous, often individually tailored activities lead to a strong sense of ownership of one's learning.

Unlike many learning technologies, mobile devices are not shared but owned and controlled by the user (creating emerging challenges for institutions used to controlling students' use of educational technologies). Learners enjoy a sense of 'belonging' and comfort with their personally owned, mobile devices. Individually chosen models, external accessories (skins, covers etc.), personalised interfaces and applications, as well as the small, portable nature of these devices, has created a sense of intimacy or *"a new habitus of media use"* (Pachler, Cook & Bachmair, 2010, p18).

Furthermore, learners often enjoy a high degree of flexibility in their mobile learning experiences. They have control over the place (physical or virtual) and time they learn, and often enjoy autonomy over the pace and content of their learning. The 'just enough, just-in-time, just-for-me' nature of the activities creates a personalised learning journey where goals are typically set by learners and their peers (e.g. games). Indeed, emerging 'context-aware capabilities' allow devices to acquire information about the user and their immediate environment (eg. time, location, nearby people and objects), presenting unique opportunities to customise learning experiences (c.f. Bio-mapping: Brentford Biopsy - http://www.publicbiopsy.net/info.htm). Furthermore, emerging 'augmented reality' applications and customised interactions with 'The Internet of Things' (Sundmaeker *et al*, 2010) offer promising ways for learners to select, manipulate and apply information to their own unique needs.

In this sense, time, place and activities are customised for the learner to meet their different learning styles and approaches. Increasingly, mobile users will use tools to record, organise and reflect on their customised mobile learning experiences over time (Naismith *et al.,* 2004). This high level of flexibility and autonomy leads to a strong sense of empowerment and ownership of one's learning (Traxler, 2007).

Examples of customisation from our projects include the use of apps which facilitated learning about the particular interests of the device's owner. Users customised their own devices to include their individual sets of apps, and often incorporated apps from individual hobbies for learning that was taking place in the third space. One such example in the Mobagogy project was an app which included a pedometer and would calculate the distance walked from the paces done. Another member of the Mobagogy group downloaded a walking tour to use in walking around a foreign town. A characteristic of usage here was that there was often much exploring and playing with apps before they were used for learning.

5. EXAMPLES

We conducted a number of trials as part of our *Mobagogy* professional learning group activities. These trials took place in a range of formal university-based and informal learning settings and included the use of mobile devices to mediate:

- the use of mobile conversational spaces (e.g. using micro-blogging) to support peer and staff mentoring in practicum-based settings;
- communication and data sharing on field trips and museum excursions in science and social science education;
- access to iTunesU and new podcast communities in English Education;
- student-generated podcasting and vodcasting in research education.

Other activities included the use of selected mobile devices to enhance interactivity and dialogue in lectures and classrooms; to facilitate media capture and to provide dissemination tools in student-generated media projects (e.g. digital narratives); and support communication processes during project-based learning tasks in science education (e.g. using geolocation capabilities).

Throughout these interventions a variety of strategies were used to promote collaborative critical reflection (Ghaye & Ghaye, 1998) amongst group members. These included reports on experiences, shared reflections and discussion on a community blog, and in face to face meetings. Ideas, reflections and work in progress were shared, with invitations for responses, by means such as collaborative web-based documents and group emails. The degree to which participants took advantage of the immediacy and convenience of malleable time frames, as well as the customised, contextual, social interactive nature of mobile learning experiences varied according to individual students and teachers. However, the variety of trials undertaken promoted both the clarification of the three dimensions (customisation, social interactivity and authenticity) of the framework presented in this paper as well as the identification of what had and had not 'worked'.

For example, ten volunteer pre-service teachers participated in the micro-blogging trial (see Schuck *et al.,* 2010). The purpose was for these student teachers to use Twitter to share their views and network with other prospective teachers and two staff from the community during their school-based practicum. Intended foci of 'tweets' included: reflections on their own professional learning as a prospective teacher; sharing interesting teaching experiences or artefacts (lesson plans, student work, photos from the field etc.); and sharing interesting teaching resources. Participants labelled their posts with a nominated group 'hashtag' and followed all posts via the *Twazzup* service. The names of their schools and the names of children and staff remained anonymous at all times.

The exercise was evaluated using artefact analysis (the Twittter feed) and a 30 minute interview with a sample of three participants (Anne, Dianne and Mark) involved in the trial. Posts (or 'tweets') were generally thought-provoking and as the trial progressed, they contained interesting photographs of classroom artefacts (e.g. students' work). Students generally liked the simplicity of micro-blogging communications as well as its convenience and immediacy, compared to traditional asynchronous discussion boards. However, participants were reluctant to react to others' tweets and the 140-character limit imposed by Twitter generally restricted meaningful discourse.

Anne used her phone to take photos on her practicum but tweeted from home at the end of the day. Tweeting made her think about specific incidents during the day and the restricted character limits in Twitter helped her "think about them concisely …". However, she found these limits challenging and she wanted to say more. She seemed to be very conscious of the potential audience for her tweets as she searched each day to post about "…things that were interesting." In her interview, she said she would prefer Facebook groups and associated discussion forums for this type of activity.

Dianne used her 3G phone 'live' in the classroom during her lessons. She asked permission first and took photos of children's work. The teacher was unconcerned about this process but the kids were very curious about her mobile use. As a regular 'tweeter', she thought the trial "lacked the normal conversation' style" and suggested a larger network was needed to make this exercise valuable. In her interview, she emphasised the time needed to grow an effective network and highlighted the need for a 'twitter literacy' to read and understand posts.

Mark used his mobile phone to take photos of children's work but 'tweeted' on the computer at school (after lessons). He often found himself in the 'lurking role': reading others' posts and seeing what they had done, usually without responding. Like Dianne, he would like to see a larger network and share ideas with more people from his own discipline (Visual Arts). He also expanded on the Twitter literacy theme, claiming it took time to get to know people and their styles of communicating. He found himself reluctantly using SMS abbreviations to fit into Twitter's character limits. He thought the micro-blogging exercise could work better if Twitter was used more for asking questions or to 'put out' something provocative that could be critiqued.

This trial indicated that the simplicity and networking aspects of services like Twitter make micro-blogging an interesting but not necessarily effective professional m-learning activity during field-based experiences. Although the exercise took place in a formal setting (a school-based work-placement) the tools, characters and processes involved in the exercise (e.g. sharing artefacts of students work, networking with teaching colleagues) were congruent with 'what real teachers do', and for one student at least, this took place 'live' in a real classroom. Students involved in this exercise were certainly engaged 'directly in the professional community' and in this way they were following a participation model of authenticity. In a similar fashion to Zagami's (2010) trial, a 'convenience dimension' became significant when the mobile device was used in the field experience to capture media and/or communicate via the network. However, despite these affordances, the degree of social interactivity would have been enhanced with a supplementary discussion forum (e.g. using blog or wiki-based platforms) with scope for more in-depth communications. Indeed, this particular trial emphasised the crucial role of quality dialogue in a customised environment for mobile learning experiences.

In the UK case study students explored the potential value of applications (apps) for their iPhone prior to appropriating some of these into classroom and professional practice. They preferred to undertake this in informal settings rather than through formal training events or even the recommendation of tutors on the course. They described the playful manner in which they downloaded and experimented with Apps often in social contexts (e.g. in the pub or coffee shop) and compared their findings and ratings, often devising their own unique rating scales. In some, but not all cases, these Apps were then appropriated and used in the classroom. For example, in the case of context aware applications such as Google Maps of Google Earth, many students used this for personal purposes, such as navigating to a social meeting or finding a location for a meeting, before considering it as a valuable teaching and learning resource for the classroom. A number of students then described how they used this type of application to help other students locate different religious buildings or identify those they saw during a field trip.

A similar example arose due to the requirement placed on the students to record a short audio-log on the phone to reflect upon their use of the device whilst on placement or away from the university. Although this application was provided to students as part of the formal evaluation of the project, a number of students described how they subsequently started to use the voice recorder facility to share memos and ideas with other fellow students, and subsequently started to use it formally in the classroom itself, enabling students to record themselves as part of role-play preparation.

We can imagine how students will use the third space as a fertile testing ground for such applications, often rejecting the majority of those which are previewed, but occasionally taking a few valuable applications forward for further exploration and use in a classroom setting. We are starting to see this informal process semi-formalized in the UK where a number of innovators bring interested teachers together in Teach-Meets to share their experiences of using mobile devices in the way described above. Perhaps this is a tangible manifestation of where and how the third space enables teachers to play with technology and pedagogies before taking them back into the first space which is altogether higher risk.

6. DISCUSSION AND CONCLUSION

Informed by a range of frameworks and descriptions from the literature, and critical evaluation of our own teaching trials and case studies, we have identified three inter-related characteristics of m-learning: authenticity, customisation and social interactivity. These distinctive features encapsulate the well-reported experiences of learners in a mobile time/space continuum characterised by fluid geographical boundaries and malleable time frames. Central to the idea of mobile learning is that learning occurs in different places and at different times and is not confined to formal learning occurring in institutions. Mobile devices support such learning through their ability to be used anywhere and at anytime. The authenticity feature presents opportunities for contextualised, participatory, situated learning; the customisation feature has strong implications for personalisation and autonomy; while the social interactivity feature captures the oft reported conversational, connected aspects of mobile learning. Of course, all of these features were not all present to the same extent in our teaching trials and other activities but we contend that they are most likely to be found during learning episodes *in the third space*. We contend that it is in this nexus of the formal and informal that levels of flexible, spontaneous, incidental learning are optimised. Experiences in these spaces are more than likely initiated, negotiated and mediated by self or peers, drawing on high levels of social networking, 'in-situ', personalised activities that take advantage of flexible schedules and spontaneous learning episodes. We believe that mobile learning in the third space displays qualities of all three characteristics identified in our framework and takes full advantage of the immediacy and convenience of a socially negotiated time and space.

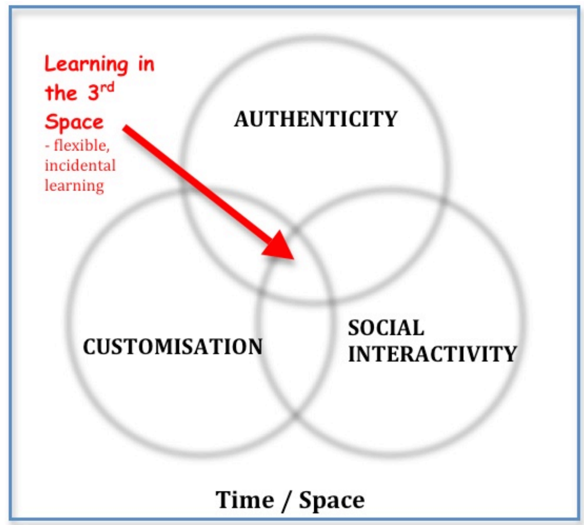

Figure 5: Locating mobile learning in the 3rd Space

Whilst these scenarios may still be some way in the future it is likely the experience of mobile learners in their worlds outside of formal education will impact significantly when they clash with the dominant modes of traditional formal learning which is spatially and temporally fixed (Traxler, 2009). Our studies in both Australia and the UK have sought to investigate and explore some of the issues which fall out of this clash of cultures based around the different spaces (both physical and virtual) participants inhabit and ways in which they mediate between and across the boundaries of these new spaces, or digital habitats, as Wenger, White and Smith call them (2009).

Future work will investigate opportunities for teacher education to take advantage of the spontaneous, often multi-modal nature of these incidental learning experiences in the third space. For example, we plan to gain insights into the possibility of using multimedia to capture, develop or respond to ideas and concepts, access information at any time or schedule, and learn collaboratively through networks in these new, informal learning spaces. This work will help to further clarify distinctive features of m-learning experiences - especially in third spaces. It will focus on how these features evolve and change as new mobile technologies emerge, and explore implications of these changes for modern learning ecologies.

We provide this succinct framework as stimulus for further discussion and debate. Identifying specific critical attributes of m-learning experiences provides a lens for future research, and helps educators understand and analyse emerging teaching challenges and design more effective mobile learning experiences and resources. We contend that the distinctive features of m-learning are currently the ones identified in our framework and are most likely to be found in third-space learning episodes. As mobile technologies develop, our challenge as researchers is to probe new and emerging pedagogical opportunities that honour principles of learning drawing on well-researched socio-cultural tenets. Central to this tradition is the notion that learning is a situated, social endeavour, facilitated and developed through interactions between people.

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The use of mobile phones to develop learning with marginalised young people

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Abstract

Unemployment levels are rising in a number of European countries and this trend is accompanied by a decrease in the availability of unskilled work. These changes in the labour market and employment opportunities have been further exacerbated by economic recession. Furthermore, the expansion of the European Union in recent years has enabled economic migration on a hitherto unprecedented scale. Disengagement from education by young people in Europe is of both political and economic concern as low educational attainment and absence from school or formal education is associated with unemployment, increased crime and poverty. The resulting social and economic costs precipitate marginalization from society by disaffected youth. Ubiquitous access to the internet and wireless technology provides opportunities to develop learning through innovative pedagogical approaches with this hard to reach group of young people. The concept of social networking was used with marginalised young people accessing an online learning platform using mobile phones as tools. This research utilized a principally qualitative paradigm to examine how learning might develop in a mobile online context with a group of marginalized young people. Quantitative data was collected and analysed to contextualise and triangulate the findings. Preliminary results suggest that where mobile phones are used in conjunction with a bespoke social networking platform and innovative pedagogical approaches, these technologies can be successfully used to develop learning with hard to reach youth.

Keywords

Learning, mobile, technology, education, marginalization, disengagement

1. INTRODUCTION

Low cost or free access to the internet has wide reaching implications for social inclusion and the potential to reduce inequality, whether it be educational, cultural, social, economic or more likely a combination of these or other reasons. The inability to use ICT and the World Wide Web has implications for employability in economies that increasingly demand highly skilled workers and often the ability to access and assimilate information quickly. Access to the world wide web is now free in many areas such as libraries, airports, train stations and even fast food chains. Some of these provide connectivity tools such as work stations as well as bandwidth, but the need to travel to a fixed site or purchase goods or services to obtain internet access can outweigh the benefits of free access. Mobile technologies such as the current generation of mobile phones provide ubiquitous internet access offering the potential to reach out to marginalized young people to develop their learning wherever they might be. This is of particular significance for transient or homeless youth and economic migrants who may frequently move and are seen as hard to reach. Access to social networking sites and a range of Web 2.0 tools is now possible from many mobile handsets, hence there is a potential to use these sites to develop online community and content appropriate for disenfranchised young people.

This research is part of a European Seventh Framework project called ComeIn which began in September 2009 and is scheduled to end in October 2010. The purpose of the ComeIn project is to research the use of online mobile communities to facilitate the social inclusion of young marginalized people. ComeIn is part of a suite of research programmes specifically funded by the European Commission to investigate whether social software can facilitate the social inclusion of at-risk youth. Although social software is considered to encompass a range of social systems that allow users to interact and communicate with each other, for the purposes of this project, the term is synonymous with social networking platforms such as Facebook and Bebo and to a lesser extent, Youtube. Marginalization has been defined very broadly by the European Commission (2008) to mean "Young people with fewer opportunities". Sub categories include educational, social, economic, mental, physical and cultural marginalization, but it is accepted that many young people belong to several categories and that the boundaries are blurred. The ComeIn project involved the development of a bespoke social networking platform targeted at marginalized young people between the ages of 14 and 21 along with the provision of some multimedia content that would help to scaffold the site.
The initial content focussed upon enterprise and learning skills and a small number of short challenge videos designed to provide a stimulus to develop

community interaction and learning. The intention was that the learning objectives and experiences would be dependent on each individual. They would be set by the young people themselves according to perceived need rather than through a predetermined framework or content delivery mechanism.

Young people could then access this site to develop their learning through the use of mobile phones, focusing on visual media and particularly video as a medium. The intention was to acknowledge the likelihood of the comparatively low literacy of the participants and a recognition of different learning styles evidenced by young people (Johnson et al., 2006). A pilot study was held jointly in the UK and Austria with marginalised young people from the two countries. This paper will focus on the UK dimension of the pilot and the potential use of a social networking platform accessed from mobile phones to develop learning with marginalized youth.

2. METHODOLOGY

There are many arguments about the suitability of inductive or deductive paradigms in the field of educational research. The Commission of European Communities (2000) has taken a view in its discussions about the future of education that qualitative methods such as action research and ethnographic approaches are given insufficient weight, suggesting that "analysing actual practice does not always receive enough attention". The Commission suggests that quantitative methodology alone is likely to be less accurate because of the lack of data and definition of precise instruments, stating that ".... from a quantitative point of view, the data available are still rudimentary...the frequency of collection and the definition of indicators are very variable and imprecise". Conversely, concerns about the validity of qualitative data are raised by Walford (1980) who critiques the generic approaches to qualitative research in education and suggests that "...non-qualitative researchers, policy-makers, researcher-funders and lay people may be less likely to take qualitative research seriously". However, Walford (*ibid*) is also equally critical of quantitative methodology when he talks about "the illusion" of quantitative research being value free, scientific and valid. Some of the debate centres around the interpretation of limited and hard data. Cronbach (1975) claims that statistical research is not able to take full account of the many interaction effects that take place in social settings. According to Motteram (1999) there is a trend towards the application of qualitative methodologies as the most appropriate for educational investigations although in practice it is becoming more commonplace to combine qualitative and quantitative methodologies if it benefits the research (Mann and Stewart, 2000). Denzin and Lincoln (1998) took this a stage further in their discussions about the researcher as a "bricolour" who would be able to draw their approach across several disciplines. In other words there is a sense of "blurring" between the different genres of research methodologies. In this research, although a qualitative approach is adopted, quantitative data is used where helpful to set qualitative data in context.

3. RESEARCH DESIGN

Desk research was used to gain an in depth understanding of online communities and marginalized young people. This research also sought to identify the key facets, which would need to be included in a bespoke social networking platform designed for marginalized young people. A prototype platform was developed for testing in December 2009. A range of mobile phones was tested to determine handsets that would allow for technical stability and function rich access to the platform. The research could then focus on the young people and their learning rather than the technology. The performance of the platform was investigated on twenty two mobile phones from six major manufacturers on four operating systems. This testing phase identified a number of phone handsets as suitable. It indicated that the Windows 6 mobile phone operating systems was currently the most stable for accessing the community platform although the Symbian mobile phone platform was demonstrated to be a possible alternative. Mobile phones were selected for use in the pilot on this basis.

Project staff involved in the ComeIn project were given access to the platform to trial and debug the community platform using four different mobile phone handsets so that a workable platform would be available for the commencement of a three month pilot starting in February 2010. A very small number of young people in the 18-21 age range were also given access to the platform in order to gain the opinions of young people of a similar age to the pilot target group and to get a better understanding of their use of mobile phones. Although these young people were of a similar age group to the target pilot group, it was recognised that they were not disadvantaged and did not necessarily fit or represent the European Commission criteria for marginalization.

Two focus groups were also held; one with experts from education and industry and one with a small group of marginalized young people. These groups were used to support content development by identifying the skills and attributes related to employability and learning skills (Johnson et al., 2009) considered to be most important by the key stakeholders. Following this, a small number of short videos which focused on learning and enterprise skills were made by professional adult film makers in order to scaffold the community prior to access by the target group of young people. Young people were then identified to take part in the pilot study. The UK pilot involved forty eight young people in all with an equal gender split. The group was also divided by age so that half were of statutory school age (14-16) and half were post statutory school age (17-21).

The younger age group were identified from a mixed group of poor or non-attenders on school rolls whose attendance had been recorded as between 0 and 20% per week over the previous year. they were only eligible if they were seen to be failing in alternative provision and where poor attendence mitigated against them achieving any qualifications.

The older age groups were identified from those who were not in education or training and were unemployed, NEETS (DfE, 2008). They were only eligible if they had failed to obtain full-time employment or college placements for at least two years. Anyone who attended college or work for more than 1 day per week was ineligible for the study. Participants were recruited through organisations working directly with disaffected youth. The intention of the original research design was to work with young people in two UK regions. However, it was not possible to readily identify a group who fully fitted the criteria of the study, thus it was extended to cover three regions, namely Greater London, East of England and the West Midlands giving a balance of rural and urban participants. A small number of the older participants were spread more widely across the regions with four from the Northwest and one from the South West of England.

Each participant was provided with a mobile phone. Four different handsets were employed. In line with the results of the pre-pilot testing, all handsets were built by the same recommended manufacturer and shared the same basic Windows 6 operating system to ensure that the operational performance of the community platform was consistent across users. All phones had 3G and wireless access to ensure that the participants had comparable opportunity to connect to the online community. The four handsets differed in their physical interface (see Figure 1). One phone had a fully Qwerty keyboard, one phone had the traditional twelve keys, one had an entirely touch screen and the fourth had a touch screen coupled with a pullout Qwerty keyboard. This variation of models was employed to recognise the variation in literacy and physical capability of the participants, but also indicated whether the hand set was sufficiently robust and fit for purpose.

Figure 1:

Mobile Handsets used for the pilot

Each phone was issued with a pay-as-you-go phone network sim card that was set up to have unlimited data access, but limited phone and text credit for the duration of the pilot. This phone and text credit enabled the project team to contact the young person to offer support and the young person to contact the team. The pay-as-you-go system was selected because it would allow the costs of data and phone/text to be separated from one another and it would also allow for easy migration to a different provider, if necessary, without being tied to long-term contracts. Pay-as-you-go was also the most common system used by the target group on their existing mobile phones.

4. RESEARCH METHODS

Typically, qualitative research employs a variety of methods and tools. Ethnographic action research is an approach that lends itself particularly to the study of the use of ICT and marginalised groups and has been employed extensively using a range of instruments. Ethnographic research typically draws from three main sources of data. These are interviews, observation and a variety of documentation. Traditionally these are personal or face to face interactions. In this study, ICT was used as a medium to draw data from all these sources and researchers acted as facilitators and moderators from within the platform. Borg and Gall (1983) suggested that participant observation was "well suited for the investigation of many educational problems". However, it is recognized that being a participant and an observer whilst still retaining the ability to work objectively is not without its difficulties. Using the internet as the foundation for major research is relatively new. Mann and Stewart (2000) said that there were few research practice conventions in internet based research, arguing that chat rooms, emailed discussions and interviews conducted online offered their own challenges to more traditional methodological approaches. Markham (1998) described the use of the internet to facilitate research as "beguiling", suggesting that data collection from this source is economical, but "deceptive in its apparent simplicity". She said researchers are influenced by the absence of visual cues and clues and can influence data accordingly, using their own mental constructs to potentially interpret data in a biased fashion. As far as possible this potential bias has been eliminated by employing a range of methods, both face to face and through ICT, and by specific training for facilitators and research staff.

4.1 Introductory Meetings

Introductory meetings with young people were held in each of three regions. The purpose was to explain the platform and the project to the participants, to issue them each with a mobile phone, ensuring that they understood how to use it, and to complete ethics forms. Venues were chosen to ensure that the young people felt comfortable and that a fast internet connection was available. This was to ensure that during the sessions, young people could focus on accessing the platform, using their phones and exploring the functionality of both technologies. Up to eight young people were invited to each session, which lasted about two hours. Between two and four adult facilitators participated dependent on numbers of young people expected. Ethics forms were signed at this point. Where young people did not attend, an introductory session was held in their home or by telephone on a one to one basis. Where a telephone session was held, handsets were posted to the participants in advance together with any necessary paperwork. For those living outside of the three identified regions, telephone sessions only were available. This only applied to the 17 plus age range. The introductory meetings, presented informally, were structured to ensure that the participant young people had enough contact time with pilot facilitators to understand the lines of communication for technical and community support and to begin to develop a relationship of trust. Informal interviews were held during these meetings to develop an understanding the young people's current use of mobile handsets, the internet and online communities. Carefully constructed questions were also used to identify their soft skills including confidence levels, communication skills and self-esteem. Levels of ICT literacy were established through questioning and observation. Previous use of social networking sites was also discussed.

4.2 Closure Meetings

Closure meetings were held at the end of the pilot using a similar format to the opening meetings. Additionally, individual video interviews and group discussions were held where participants were willing to do so. The data collection requirements were agreed in advance of the sessions, but open-ended questions and informal techniques were applied to the questioning. Facilitators were fully briefed in advance as a group and before each individual session. Facilitators completed their research diaries immediately at the end of each session to ensure accuracy of data.

4.3 Research Diaries

All facilitators were required to keep research diaries covering the induction sessions, closing sessions and all correspondence for the duration of the pilot. These diaries were coded and analysed using key words. Training was given to all facilitators in groups to ensure consistency.

4.4 Use of the Bespoke Learning Platform

The platform was tested three times a day to establish whether it was accessible and whether all features were working. All interactions between UK project staff and the young people on the platform were mapped and monitored during the pilot. Quantitative data, collected and summarised weekly, included login sessions and community activity. This information was mapped against qualitative analysis such as the research diaries and communication logs to contextualise the research and to ensure triangulation.

4.5 Use of Mobile Phones

Use of mobile phones was monitored. Phone calls made and received by the facilitation team were recorded. Text messaging was used extensively for the pilot. The purpose of the text messaging was to provide community support, technical assistance and to encourage participants to use the platform and its range of tools. Text messages were also used to elicit feedback about the system; its design, functionality and its use. All texts were kept and logged on a bespoke database for further analysis.

5. RESULTS

The results of the pilot need to be viewed in the context of the stability of the platform. Whilst statistically it was available for over 90% of the time and thus access could be considered good, this was not reflected by the experience of the participants. Those with access to broadband wireless networks were able to connect consistently to the platform throughout the pilot with few exceptions. Those who only had access via 3G experienced disrupted access throughout the pilot and the ability to view movie clips was only available for the second half of the pilot period when this technical problem was resolved. One young person said; "The only thing im finding a little hard is the fact that i still cant view [videos]." (sic) This was relevant because the content used for scaffolding the platform was short movies.

The pilot lasted for twelve weeks between February 2010 and May 2010. Introductory and closure sessions took place over five working days to ensure concurrent access and use for as many of the participants as possible. Of the forty eight marginalized young participants, only one failed to take part after the initial induction meeting where their phone was issued. This young person was of a traveller background living in an extended family group and of low literacy level. Travellers in the UK are recognized as a hard to reach group and culturally do not readily associate with those from a different cultural background. Having reached the age of 16, she had become transient, travelling regularly to the north-west of the country to prepare for her wedding in three months time. Furthermore, with only two travellers in the pilot study, there was no cultural imperative to continue to participate in the pilot and no established friendship groups in the online platform. Of the forty seven remaining, three lost their mobile phones at various stages of the pilot. One was replaced and subsequently lost again. The remaining two were not replaced. One of these young people continued to participate using an alternative means of access.

Although limited credit was given to users to enable them to access the internet and upload or download data, it was noted during closure sessions and interviews that all young people were using the handsets provided as their principal mobile phone, having transferred their address book to the phone. This implied their intention to continue to use the handset beyond the pilot. The use of text messaging in the pilot was significant with over one thousand texts exchanged between facilitators and participants. 36.7% of the texts were communications involving queries of a technical nature whilst 28.9 % were data gathering. A further 35.4% concerned engagement with the study.

There were no discernable differences in participation by gender, but those aged over 16 were more active. Development of soft skills (Simpson, 2006) amongst participants was evidenced. In all cases, facilitators reported improved confidence and self-esteem at the end of the pilot compared to the beginning. This was observed by facilitators during the face to face sessions and during telephone interviews. Examples include a willingness to take part in-group discussion, a willingness to give feedback about the pilot to an audience, a willingness to show and share work with an audience who were not involved in the project and a willingness to be filmed or recorded.

Almost 44% of the 17-21 age group had been accepted on college courses or obtained employment since the beginning of the pilot. These young people had neither been employed nor attended college places for at least two years and were not part of the recognised "NEET churn"[1].

Overall, the bespoke online community platform was liked by the young people with 25% reporting social networking as their favourite aspect. One young person commented that “I like the news feed type thing on the home page cos im nosey and i think the platform is very eay to use” (sic). A second young person noted that “I like how u can c who else is online” (sic). A further 15% commented that they liked the way they could set up and join interest groups online, although slightly under 30% had actually joined interest groups. Notably, only one participant highlighted mobile phone credit as important. About 60% of the participants demonstrated an awareness that they had a positive experience during the pilot by either making and collaborating with new friends (43%) or by learning something new and exciting (49%).

The lower textual literacy of marginalized young people compared to their peers is well documented and the intention had been to scaffold the platform with short video clips which focused on learning and enterprise skills and to encourage the participants to develop and upload user-defined video content. However, video capability on the platform was fraught with technical difficulty and 94% reported difficulty accessing video at some point, limiting the way learning could be measured in a multimedia context in this pilot study and limiting research into innovative pedagogical approaches. One young participant commented that “...the uploading is pretty simple but takes too long to upload a 1 minute video”, “While uploading a one minute video the connection timed out and it stopped up loading ” (sic). Nevertheless, 75% managed to upload a short video they had made during the course of the pilot.

Views were also sought on how the platform could be improved. The absence of a user profile with a picture was the most common feature identified. Two young people agreed in a community discussion that “[we] don't like how u cant customiz [sic] your profile” (sic). Young people also requested the incorporation of a chat room. Participants' comments included references to other known community tools or social networking sites: One young person said that they would like to see “an easyer way to talk to ppl instead of sending a message and waiting for a replay like a way to talk like on msn” (sic). Another young person suggested “i'd like to see maybe just a status box added, like a tweet of what your up too” (sic). Other improvement suggestions centred around the visual design of the platform. One young person commented; “ I don't like how plain it is. I would like 2 c more colour on the site” (sic).

Participants commented on the speed of the platform which was important to them, but it was noted that this appeared to vary from one region to another suggesting that internet coverage was the cause, rather than the server. Connection speed monitoring by the pilot staff found marked differences between the wireless connections, strong 3G signals, poor 3G signals and GPRS signals that the mobile handsets could access. It was difficult to gather research data from the young people about their internet connections because they did not appear to understand the differences between the varying connection types, were unable to easily switch between connections and were not aware that their handsets would automatically switch between services depending upon their location.

CONCLUSIONS

From this pilot study, it can be concluded that mobile phones can be used to develop learning with marginalised young people however the research indicates that the effectiveness of the participants' experience is likely to be dependent upon seamless and functioning technology. Congurent with Kendall et al (2001) the context where the learning takes place is shown to be more critical than the content where engagement of marginalised young people is concerned. Regardless of whether the stability of the technology is dependant on server location, the mobile phone providers or a combination of these is of little

1 NEET churn refers to young people who move in and out of the NEET group and can include those who are in between jobs or courses but who are not long term NEET.

consequence to the user who is attempting to log on and take part in learning activities. Where technology gets in the way of learning as opposed to being a useful tool then the development of that learning is likely to be compromised and inhibited.

For those young people who are marginalized, learning needs to be viewed as a whole and not simply in terms of formal and informal learning, or learning which leads to accreditation of some sort.

Whilst there is clear evidence of ICT and technical learning, development of soft skills cannot be underestimated particularly where it leads to these young people becoming net contributors to the economy and to society, as is suggested by the numbers achieving college places or employment. This suggests that building a mobile online learning community for marginalized young people to facilitate their learning is a viable prospect. The specific use and benefit of the bespoke platform as opposed to designing and developing a secure area within an existing social networking site is less clear. Evidence drawn from the breadth of participation of the community suggests that most young people reached stage two or three of Salmon's "5 stage model" (2000) in this very short pilot project. It is not possible to predict whether an extended pilot would have meant further engagement and deeper learning or whether access to the community would have diminished over time.

In this pilot, handsets were given to young people who were aware that they would be allowed to keep them providing they took part in the pilot. Some limited credit was also given to allow them to access the learning platform. This was necessary to ensure access was available the young people but it may have also contributed to a motivator for engagement that is not directly related to the aims of the pilot. It is recognised that whilst phone technology is developing and costs are reducing, those on the margins of society are least likely to have access to the new technologies. Future research would need to establish whether the target group would be able and willing to access an online learning platform if the technology was not provided together with some guaranteed access through a credit system. Early indicators from this research suggest that cost is not a primary reason for access.

The extensive use of text messaging between facilitators and participants suggests that this medium can be used to facilitate learning with this group of young people as a stand alone tool, without necessarily having access to a social networking or bespoke learning platform. However, a bespoke platform enables an online community to develop and an opportunity to exchange and develop learning materials in a much broader context than one simple tool such as SMS or the range of tools available on a mobile phone. Although it is significant that the limitations of multimedia in this platform and particularly video meant that it could not be thoroughly tested, it is evident that the young people were comfortable using video as a medium on a learning platform. This would need to be addressed in future research.

Results indicate that the potential for the use of mobile phones to develop learning might be better targeted at the slightly older group of learners who had left school but were not in education or training. However, numbers of participants in future research do need to increase. Research by Johnson et al. (2006) has indicated that scale matters and between 50 and 100 active participants are needed to enable an online community of practice to thrive. Numbers in this pilot are at the lower end of the scale although it is interesting to note that it appeared successful despite this.

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Cloud as Context: Virtual World Learning with Open Wonderland

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Abstract

Contextual learning takes place in an environmental frame of reference, but sometimes providing suitable learning environments in the real world is not possible. Virtual worlds have the potential to provide immersive learning environments for distributed learners and enable contextual frames of reference that can open up new and previously unimagined learning spaces. These environments can provide experiences that cannot be replicated in the real world due to constraints of time, space and/or resources. However there are complex decisions to be made when selecting a virtual world platform for a specific learning environment. In particular, non-functional requirements can have a significant impact on the suitability of a given tool. In this paper we describe a virtual world learning context created using Open Wonderland to enable geographically dispersed participants to learn about agile software development techniques in a collaborative, immersive workspace. We discuss some important issues in our choice of platform, describe our learning environment, and report on the results of technical usability testing.

Keywords
Virtual world, MUVE, Open Wonderland, agile methods

1. INTRODUCTION

The last decade or so has seen an increasing interest in multi user virtual environments (MUVEs), which provide immersive 3D virtual worlds. MUVEs combine many of the characteristics of instant messaging, IP telephony and social networking web sites, but in an immersive environment where users are represented by avatars to enhance user interactivity. Educators are increasingly looking to such environments to provide new contexts for learning. Some of the perceived benefits are that a MUVE overcomes the need for learners to be physically present, and that resources that can be made available that would otherwise be expensive or difficult, even impossible, to provide. Within a MUVE we can use the power of a 3D software environment to create 'things that never were nor could be' (Brooks, 1995). For example Bainbridge (2007) suggests that undertaking scientific enquiry in virtual worlds enables us to perform experiments that would otherwise be unethical (e.g. modelling an epidemic by spreading disease amongst avatars) or impossible to administer (e.g. manipulating an environment or gathering data from very large numbers of participants.) From a different perspective, a MUVE can act like a 3D Wiki, because of its support for collaborative document management (Waters, 2009). Thus we can see such tools as the route that can take us from Web 2.0 functionality to the meshing of 2 and 3 dimensional resources in the *Metaverse* (Smart et al, 2007). By shifting the context of our learning into the cloud, creating customised environments that can be inhabited virtually on the web, we can explore entirely new worlds of teaching and learning.

There are, however, major challenges for the educator. A number of significant MUVE educational projects have come and gone as their project funding has terminated and, as Salmon and Hawkridge (2009) note, we cannot know at this stage whether are we at the beginning of a major development in learning technology, or already towards the end of its potential. One critical factor that will influence our success in using MUVEs for education is the difficulty of going beyond those things that are relatively easy to deliver, such as virtual historical or cultural environments that avatars simply explore. Once we move into more challenging areas of delivering complex knowledge, the difficulties of building such tools may create significant barriers to progress (Atkins and Caukill 2009).

In the following section we introduce the context in which we aim to deliver complex knowledge. We follow this with our conceptual framework, and then describe our technical implementation. The paper concludes with the results of testing and evaluation and some suggestions for future work.

1.1 A MUVE Based Learning Context

In order to advance understanding and appreciation of the possibilities of delivering complex knowledge we have taken an existing interactive workshop on agile software development, currently used in a traditional face to face setting with professionals and university students, into the virtual world. Currently, this workshop can only be experienced in the real world, limiting its reach to those who are able to physically attend scheduled sessions. By building the support tools for this activity into a virtual world, we hope to extend its reach to a wider population of learners. As the system develops we also hope to provide significant process and tool support to make it easier to use than the classroom based version.

The choice of the agile workshop as our learning content is motivated by a desire to focus the *use* of teaching technology on the teaching *of* technology, an attempt, perhaps to eat one's own dog food. Another opportunity in addressing a technology topic is that it can apply equally to students or professionals. A virtual world can provide a rich and productive environment for professional development (Waters, 2009). Since professionals often find it difficult to attend educational provision away from the workplace, virtual world learning can increase access to professional development.

1.2 A Conceptual Framework

In order to provide a conceptual frame of reference for our work, we have taken note of a number of perspectives, including resource views, immersion, game based learning and sociological and courseware perspectives. In previous work we have sketched out an analytical framework for approaching the creation of different types of learning context in virtual worlds from a resource view (Parsons and Stockdale, 2009.) The key assumption of this framework is that there are three levels of resource ranging from basic through interactive to creational. However this perspective alone is not rich enough to fully conceptualise the virtual world learning space. Therefore we have extended our analysis to consider further perspectives.

Gardner et al's (2008a) extensions to Mayes' (1995) framework appear useful in this respect. Again there are three levels; conceptualisation, construction and dialogue (application). In a virtual space these can be mapped to the concepts of immersion; psychological, physical and social. Mayes' original framework is based on the categorisation of courseware, which is divided into primary (subject matter), secondary (environment, tools and tasks) and tertiary (produced by other learners), as examined further in (Mayes and Fowler, 1999). In Figure 1 we have integrated these various perspectives and mapped them to our virtual world workshop activity. This has helped us to understand to nature of the work that we are undertaking in ways that go beyond simply delivering subject matter (conceptualisation). We can recognise that our work already addresses some core concepts of construction and dialogue, but are also able to identify the key themes that should continue to be the focus of future work. We are also aware of further perspectives that may help to contextualise our aims and objectives.

Activities such as the one described here can address their analysis from a relatively simple emergent process perspective; 'how such a world enables and constrains distributed collaboration' (Orlikowski, 2010 p.132) However we also have an opportunity to apply an analysis from the perspective of entanglements, whereby the agency of the individuals and technology may be helped by their relationships (Orlikowski, 2010). This aspect is one that needs to be addressed in building collaborative process management within the activity.

It is also useful to frame our analysis within the context of immersive virtual worlds being an aspect of (serious) game base learning. Indeed, Wonderland is built upon the Project Darkstar game server. This can cause issues of perception, however, since 'Differing definitions of immersive learning abound and create problems when discussing the subject of educational or serious games.' (de Freitas, 2006 p.6), thus we have to be careful of the terminology we use to make it clear that whilst we may be working in a serious games environment, what we are doing is not really gaming. Nevertheless we can leverage the power of games engines for other purposes. Brooks again; 'Virtual worlds, or synthetic environments, hold great promise for training...It is ironically sadly characteristic of our culture that these promising uses will be enabled, if at all, as by products of

Framework concepts	Types of immersion	Mapping to Agile Workshop
• **Conceptualisation** ⇨ • Primary courseware: subject matter • Basic resources	**Psychological immersion (abstract space)** ⇨ Deliberately abstract; explorative; self-directed; experimental; multiple representations/visualisations	**Pre workshop activities** Need to be designed to cater for different backgrounds and experiences, access materials and experiment with tools
• **Construction** ⇨ • Secondary courseware: environment, tools and tasks • Interactive resources	**Physical immersion (physical space)** ⇨ Deliberately concrete; realistic behaviours; manipulative, role playing; multiple viewpoints; tutor directed; expected outcomes	**Workshop context and process** Multiple realistic software development roles, organised by moderator, assessed products and learning outcomes
• **Dialogue** ⇨ • Tertiary courseware: produced by previous learners • Creational resources	**Social immersion (social space)** ⇨ Deliberately situated; localised conversations; identity; reactive avatars; meeting rooms	**Workshop environments** Custom built context, localised team and developer rooms, co-located avatar conversations required

Figure 1. A conceptual framework for virtual world learning mapped to the agile in wonderland workshop (adapted from Gardner et al (2008a) and Mayes and Fowler (1999))

our desire to be entertained' (quoted in Blundell, 2008). Nevertheless we at least have the benefit of being able to leverage game software for educational purposes, and our aim should perhaps be to try to retain the engagement, enjoyment and challenge of gaming when repurposing such platforms for more serious tasks.

2. IMPLEMENTING THE VIRTUAL AGILE WORKSHOP

The agile software workshop activity has been used in a face to face context on many occasions, and is freely available on the web (Parsons and Cranshaw, 2007). In this workshop, groups of participants work in teams to design a human powered vehicle by drawing individual features, based on user stories, on overhead transparencies. The activity takes place over 3 iterations, each one introducing new agile techniques. The intent of the workshop is that the participants come to appreciate both the meaning and value of these techniques both individually and as a cohesive set by experiencing working on a task which becomes easier as more techniques are made available. Further details on the workshop can be found in (Parsons, 2008).

Since one of the most useful features of a MUVE is that the participants can be remote, the objective of this research was to see if this workshop could be delivered within a virtual world environment so that it could be run for groups of participants who were not co-located. The minimum requirements of this activity were that:

- User stories should be available to the participants.

The system has to have some way of providing a specific set of stories to an individual user based on a selection made dynamically by the person in the role of stakeholder.

- The participants should be able to draw features of user stories.

In the original workshop, participants in the role of developers draw individual features (taken from user stories) on separate overhead transparencies. Some way of enabling participants to draw features was required.

- Participants need to be able to combine their features together at the end of an iteration

The system needs to provide some way of combining individual feature pictures into a single picture. At the end of an iteration in the live workshop, the feature transparencies are laid on top of each other to make the overall vehicle. The system needs to provide some other mechanism so that the separate drawings can be merged together to provide an overall set of features.

2.1 Selecting a Virtual World Platform

Creating a virtual world learning environment is a major investment for any educational institution, and the choice of platform is a significant commitment to the evolution of any project in this area. Using a commercial MUVE such as Second Life requires investment in virtual land, the scale of which needs to be significant if it is to provide adequate access to virtual resources. Choice of an open source platform reduces initial outlay but implies other costs in hosting dedicated servers and providing the human resources to further develop the software.

In our research to date we have worked with Second Life, Open Simulator and Project Wonderland (now Open Wonderland) in an effort to identify the most appropriate platform for our own work. After reviewing the work of others and from our own experiences we decided to work primarily with the Wonderland platform as the best option for implementing the core functional requirements we have outlined above. Gardner et al (2008a) have outlined some of the key pros and cons of choosing Wonderland as a virtual world platform for teaching. On the plus side, Wonderland is open source and extensible, and more platform agnostic than many open source alternatives due to its Java codebase. It also enables greater control over resource access, privacy and security than the commercial Second Life with its publicly shared infrastructure. In contrast to Second Life, the primary intent of the Wonderland platform is that it can be tailored and integrated by organizations within their own infrastructures. (Gardner et al, 2008a). One of the potential issues with this is that the system works well within an organisational firewall but there may be problems providing equal access for remote users. For example in order for Wonderland to function correctly a large number of ports must be opened on the server, which may be regarded as creating potential vulnerabilities. At a minimum, Wonderland requires TCP ports for the Wonderland client web connection and the main connection to the Wonderland server, a UDP port for audio signalling and ideally another 200 UDP audio channel ports.

There are, however, a number of alternative open source virtual worlds, In addition to Wonderland, the Immersive Education Initiative's 'Platform Ecosystem', which consists only of freely available open source technologies, also includes Open Cobalt, Open Simulator (OpenSim) and realXtend, along with an enhanced descendant of the open source Second Life viewer (Media Grid, 2005). How the open source virtual world market will play out over the next few years remains to be seen. Our choice of Wonderland was partially influenced by its origins at Sun Microsystems and the support of that vendor. However in February 2010 following the acquisition of Sun by Oracle Corporation, support for Project Wonderland was withdrawn. The project has since been renamed Open Wonderland and is now entirely supported by an open source community.

Kappe and Gütl (2009) list the following non functional requirements as important in their own virtual world environment; Security, Flexibility, User Experience, Open-Source (customizable) code and Cost effectiveness.

Although their functional requirements differ from ours, these non functional requirements were also important in our selection of a particular virtual world platform. It is notable that Kappe and Gütl (2009) used these criteria to select realXtend as their platform. Therefore, as we note in our conclusion, our decision to work with Wonderland over that last two years or so was taken from a pragmatic standpoint, but this platform choice may change in the future.

2.2 System Description

The virtual world that we have created consists of a large virtual building with four separate team workspaces. Figure 2 shows the typical view of an avatar when the client is first launched. The user begins at the front of a four winged building, each wing containing a separate project team room. In the centre of the quadrangle is a large 'integration test' whiteboard which is used by all teams for the assessment phase of each round of the workshop.

Figure 2. The exterior of the workshop building, showing the entrance to the four main team areas and the 'integration test' whiteboard.

Each team workspace comprises a number of developer rooms that each contain a whiteboard and a PDF viewer showing user stories. There is also an editable whiteboard where individual features can be drawn. Figure 3 shows an avatar inside one of the team areas. Separate developer areas are visible containing the whiteboards and story boards. There is also a shared notes board in the central (shared) area.

When an iteration is in progress, developers will be drawing allocated user stories as individual features on whiteboards (one story = one feature = one drawing). Figure 4 shows an example where the user story 'The driver must be protected from attack by wild animals' is being implemented. The developer has drawn a cage-like structure that can be applied to the vehicle.

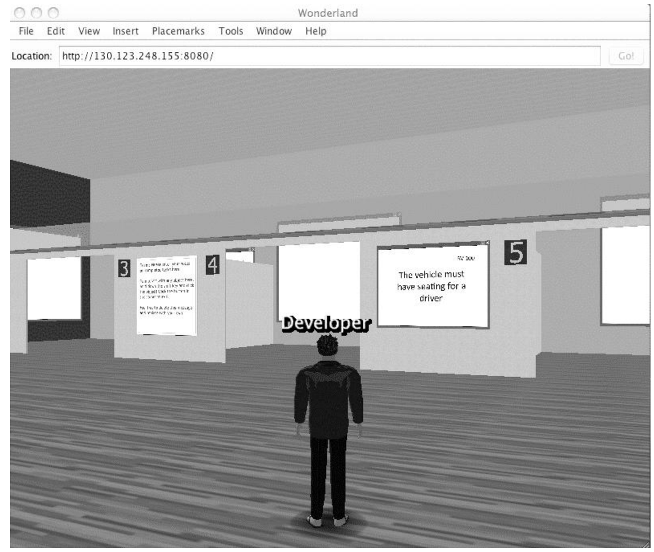

Figure 3. Outside the developer rooms, showing whiteboards, notes board and user stories in the PDF viewer.

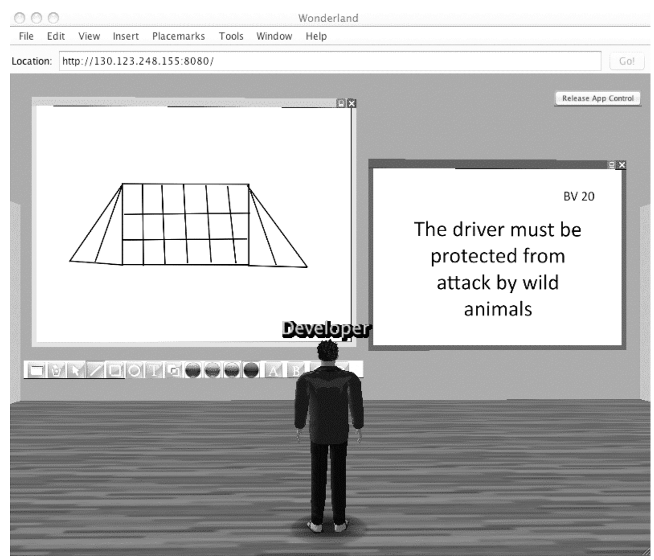

Figure 4. Implementing a user story on a developer whiteboard

Each time a developer completes the implementation of a specific user story, s/he commits that feature to the team repository by clicking the appropriate team button (A, B, C or D) on the whiteboard tool bar. This will clear the whiteboard ready for the next feature. Figure 5 shows the developer working on the next user story, 'The vehicle must be able to travel over rough and uneven ground'. In this example the developer has drawn large wheels with caterpillar tracks. Again, on completion of the drawing, the feature will be committed to the team repository.

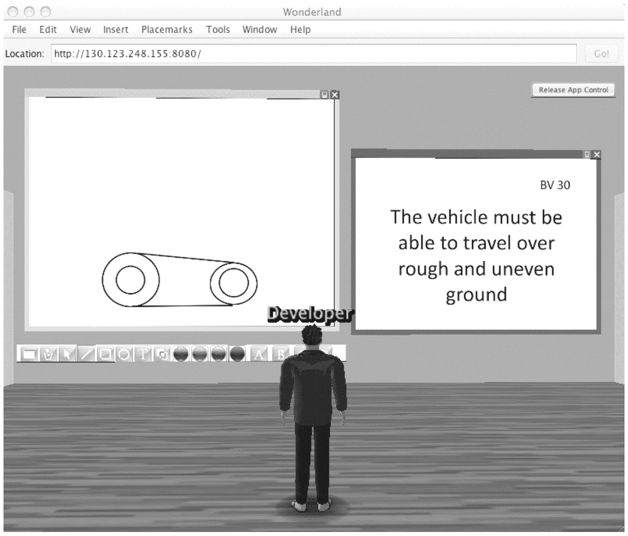

Figure 5. Implementing a second user story after the first has been committed

In a complete iteration, there will be four developers simultaneously working on a number of user stories. However to simplify the figures, the example used here uses only the two story implementations from Figures 4 and 5. At the end of the iteration, the teams will gather round the integration whiteboard. Each team's overall design, consisting of all the individual features layered together, can be viewed by selecting the team's identifier from the toolbar. Figure 6 shows the two features from our examples being combined for the team. Note that the toolbar on this whiteboard does not contain any drawing tools. It is only intended to integrate all the features from a single team and display them as a single image.

Figure 6. Combining user stories on the integration whiteboard

3. TESTING AND EVALUATION

This section describes a number of practical tests that we carried out on the initial deployment of the system. The evaluation here is somewhat basic, focused only on some tests of system usability on different platforms, but nevertheless it may be helpful to others who wish to deploy a Wonderland virtual world for their own purposes.

3.1 First Evaluation

In our first evaluation, we deployed a fairly large virtual world and tested the configuration with a group of nine postgraduate students all working in a Windows XP lab within the same university network as our Wonderland server. The participants were asked to connect to the Wonderland server, navigate the virtual space, and interact with the design tools. The session lasted about 30 minutes. It began with an explanation of the project, its purposes, and the reason for undertaking the test. The participants were asked to carry out a number of interactions with the system (e.g. view multiple stories on the PDF viewer, draw on the whiteboard) and report back on their success in completing these tasks. The purpose of this test was (a) to ensure that the server configuration was able to support multiple users, and (b) to provide general feedback on the usability of the system. A number of performance issues were identified relating to the client side application. One of these issues was that the first time a client machine connects to Wonderland there is a large set of Java archive downloads that take place before the client starts. This improves on subsequent connections because the archives will have been locally cached. However as the evaluation progressed it became clear that the client application improved in performance over time even after this initial download, presumably as it was able to download and cache more features of the virtual world incrementally. We also observed some apparent contention with multiple simultaneous logons, whereby some participants were unable to successfully start the client on the first attempt, but were able to do so later. We suspect this may be related to some known issues with collision detection in Wonderland, with multiple avatars being created at the same point in the virtual world and colliding with each other. The suggested fix for collision detection issues is to disable it in the client, but this can only be done once the client has started. Therefore some staggering of client start-up may be required. Overall the response from the participants was that the workshop tools looked interesting but there were significant performance issues that made it hard to perform meaningful evaluation of these tools.

Following the first test session, we experimented with a number of configuration aspects, including making a much smaller virtual world to see if this affected the initial start-up issues. We had run a number of tests of system functionality within our own university network, but were also aware that the university proxy servers and firewalls could limit the practicality of running virtual world workshops for clients outside of this network. Having gone through the necessary procedures for making our server URL and ports accessible from the wider Internet, we needed to have a realistic test of whether we had successfully configured the server for public access. For this reason the next usability test was carried out in a different university located in another part of the world.

3.2 Second Evaluation

For the second test, twelve postgraduate students voluntarily attended a session in which they brought their own laptops and attempted to connect to the Wonderland server, navigate the virtual space, and interact with the design tools. The session lasted about 90 minutes. Again it began with an explanation of the project and the participants were asked to carry out a number of interactions with the system and report back on their success in completing these tasks. The purpose of this test was (a) to ensure that the server configuration was able to support multiple users at a remote site outside of the university network firewall, and (b) to provide feedback on performance of the client software on different machines running a range of operating systems. In the tests, the following operating systems were being used by various members of the group; Windows XP, Windows Vista, Windows 7 and Linux. The test demonstrated that there were no issues with multiple external connections to our server and that all the basic connection channels were available. However we were unable to use the voice tools because of the number of ports that were open through the university firewall. Other than this we found that the performance of the system was comparable with running inside the local network. This further underlined that the main performance issues were not related to factors such as network latency or server response, but in the client side application.

Although general feedback on the system was positive in term of its intent, and the tools we were trying to provide, most of the negative responses related to aspects of the system that were generic to using the Project Wonderland client with its slow start-up. However there was also some useful feedback on where 'drag and drop' functionality was needed within the workshop tools.

A number of specific usability issues related to navigation did emerge as a result of these participants exploring the virtual space. One problem was that the modified virtual space was now too small, making it hard to navigate around the walls, whiteboards and PDF viewers. Users found themselves jammed against virtual walls or going through them, making it hard to properly work within the space. Minocha and Reeves (2010) stress the importance of designing for accessibility both in look and function. They stress the importance of having plenty of space to navigate between things, which is easy to create in a virtual world without physical constraints. Although the use of a small space in our prototype had been prompted by performance concerns, making the space smaller to test if the size of the virtual world has an effect on system performance that would impact on usability, this possibility was not borne out. As a result of our tests it became clear that most latency problems were not related to the size of the virtual world but related to critical differences in clients running with different graphics configurations, both hardware and software.

3.3 Follow-up Testing

As a result of our test sessions a number of questions were raised which we attempted to resolve in series of follow up tests. One issue that arose was whether the usability of the client was dependent on the operating system being used despite the supposed platform neutrality of Java. In the second test the two students who were running Linux clients had the best user experience, finding the client responsive and easy to use. Two other students who were running Windows 7 were unable to successfully run the client application, which failed to fully load. Between these two extremes, the Windows XP and Vista users found the client useable, but not as responsive as the Linux client. Whilst such issues may seem relatively trivial, they were important to our evaluation group. One responded; '*Last but very important issue you need to fix…Windows 7 as I was struggling…and could not participate as fully as I wanted*.' Therefore as a result of these observations and responses we ran a number of subsequent tests, where we attempted to diagnose the apparent issues associated with the client operating system.

We re-tested the system with both Windows 7 and Linux clients and analysed the system logs. As a result of this analysis it became clear that the problem with some Windows 7 clients was due to an issue with graphics drivers so this could be easily resolved by updating the drivers. It also appeared that client performance was largely dependent on the quality of the graphics card in the computer. Running a Linux client on a standard graphics card revealed performance comparable with Windows clients. As Roebuck (2008) states, Wonderland ideally requires a 'modern game hardware' client with powerful graphics capability. Thus, in selecting a client, hardware capability (with the exception of graphics drivers) is more important than software.

Another issue that became evident in our follow up testing on different platforms was launching the client from the initial web page. Wonderland uses Java Web Start, which requires that the Java run time version 6 or above is installed on the client. In some tests we found that the browser client may not automatically map the web start file (Wonderland.jnlp) to the required 'javaws.exe.' web start application, and manual file association was required.

Table 1 summarises the contexts and issues that arose from the evaluation sessions and the possible solutions to problems that became evident during these sessions. As a result of these test and results we are now able to ensure that clients can connect to the server with minimal technical difficulty, enabling us to move onto an evaluation phase that focuses more on the user experience and learning outcomes.

Table 1. Lessons learnt from evaluation sessions

Session Details	Issue	Resolution
9 participants Single client platform Large virtual world Local site	Slow client startup	Allow time for clients to load before activity, 'prime' clients by ensuring client archive files have been previously downloaded. Reduce size of virtual world?
	Apparent avatar collision /contention issues with simultaneous logons	Stagger logons to avoid collisions, turn off collision detection as soon as possible
12 participants Multiple client platforms Small virtual world	Apparent differences in client operating system performance	Tested specific platforms, diagnosed log files, detected issues with graphics cards and drivers
Remote site	Navigation problems	Increased space between objects and walls
	Application fails to start	Ensure correct version of Java is installed and 'jnlp' files mapped to javaws.exe

4. RELATED WORK

There is a huge amount of activity in using virtual worlds for learning, so here we focus on work that relates specifically to virtual world activities concerning software engineering education and/or projects that use the Wonderland platform. Two educational projects that have previously used the Wonderland toolkit are MiRTLE (Mixed Reality Teaching and Learning Environment) (Gardner et al 2008b) and Darkstar University (Sun Microsystems 2007). MiRTLE (a project of the University of Essex) provides a virtual classroom environment. A remote lecturer is recorded with a web cam and this is beamed to the students. Students can ask the lecturer questions as if they were attending a real-world lesson. Darkstar University is a business venture to provide a virtual learning environment to universities and colleges from countries including the U.S., U.K., China, Canada and Australia.

Using the Second Life platform, some previous work has been undertaken to deliver both computer science education and software engineering games. Ritzema and Harris (2008) used the Linden scripting language within Second Life to teach introductory object oriented and event driven programming. They also used Second Life 3D simulations with more advanced learners who were working with physical adder circuits and Mealy machines in a real world lab. Virtual world simulation tools for these devices were used to support the physical world activities. Ye at al (2007) developed two multi-player online versions of software engineering educational games from other sources, namely Groupthink (from M.I.T.) and SimSE (from the University of California Irvine.)

Bringing both virtual world software engineering activities and Wonderland together, the WikiDev3D project uses Wonderland to visualise the growth of software artefacts and their relationships over time in a project, using a city metaphor. Users can replay the development process from multiple perspectives to assist their understanding of software development processes (Stroulia, 2010.)

5. CONCLUSION AND FUTURE WORK

Our work to date has brought us from early work with Second Life, though evaluation of multiple virtual worlds, into an iterative cycle of development with Open Wonderland that has already progressed through two significant prototyping exercises with different versions of the platform. We have been able to undertake usability testing at the technical level that has guided us in our current work to bring the virtual world workshop to the verge of practical utility. There is still, however, much work to be done to be able to demonstrate the true potential of this type of learning context. Now that we have overcome most of the technical issues in deploying our workshop, we need to further refine to tools and integrate more automatic activity management prior to further user evaluation. Our current implementation lacks some of the required 'conceptualisation' content within Wonderland itself. Currently our informational materials are locally hosted in a Wiki using JAMWiki. However this material is not suitable for the required psychological immersion in an abstract space that might approach the characteristics of a suitable metaverse. Future work will include building an environment similar to Second Life's 'Orientation Island', that will enable participants to familiarise themselves with the tools and activities within the workshop prior to participating in a managed workshop process. The 'physical immersion' aspect of the system also needs further development to ensure that it fully delivers the workshop's learning objectives, while the 'social immersion' will be an interesting focus for further qualitative evaluation. We also need to be mindful of the ongoing development in virtual world platforms, and continue to monitor if Open Wonderland remains our platform of choice.

Looking further ahead, continuing technical developments mean that mobile clients to virtual worlds, including Java worlds, are a realistic prospect (e.g. Rodrigues et al., 2006). Such clients open up new potential for augmented reality virtual worlds that can blend the virtual with the actual. These developments will further challenge our ability to fully leverage their educational potential.

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Remote fieldwork: Using portable wireless networks and backhaul links to participate remotely in fieldwork

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Abstract

Fieldwork is an important means of contextualising knowledge and developing subject-specific and generic transferable skills. However, field locations are not always accessible. To address this problem we present a remote fieldwork approach that makes use of a portable wireless network and other mobile technologies to support fieldwork at a distance. As well as improving access to fieldwork, this approach can also be used to provide communication tools to fieldworkers, enabling them to share their findings and talk to their colleagues while in the field. This paper presents the portable communications toolkit we have developed and reports on three recent trials.

Keywords

Fieldwork learning and teaching; Wireless Local Area Network (WLAN); 3G mobile broadband; Broadband Global Area Network (BGAN) satellite terminal; Voice over Internet Protocol (VoIP); MPEG4 video streaming

1 INTRODUCTION

Fieldwork is a general concept used to refer to "all outdoor teaching and learning activities" (Butler 2008, p.10). It is considered a central and critical element of geoscience learning and teaching (Fuller et al. 2006; Boyle et al. 2007; Maskall & Stokes 2008). Within the geosciences it "enables students to contextualise knowledge and make sense of the world through hands-on interaction with their environment, and to become proficient in a range of subject-specific and generic transferable skills" (Stokes & Boyle 2009, p.291).

As part of the Enabling Remote Activity (ERA) project at the Open University (OU), we have developed the educational use of mobile and network technologies to improve student access to fieldwork (Gaved et al. 2006; Gaved et al. 2008; Lea & Collins 2009). Through this work we have produced a generic portable communications toolkit to support mobile learning in a range of fieldwork contexts. While not attempting to replace direct fieldwork experiences, the remote activity approach can be used to improve access to fieldwork for nearby students (within a few kilometers) over a local area network (see Figure 1), and distant students on the internet (see Figure 7).

An important aspect of the project has been to ensure that the technology is developed in response to the needs of our students and teaching staff rather than being lead by technological innovations. Through use on successive residential schools, developmental trials, and evaluation studies we have also refined our use of the toolkit for learning and teaching (see Section 3).

Figure 1. An example of remote fieldwork used on an OU residential geology course. The field geologist shown on the left is taking a photograph for the remote students to work with (shown on the right).

The ERA toolkit is used on a third level OU residential fieldwork course in Scotland to improve access for mobility impaired students. The project began in 2006 and the approach adopted was to provide a local temporary wireless (WiFi) network that could relay photographs and video from a field site to a nearby remote student. Two-way radios were used to support converstaion between the remote student and the field geologist. Since then we have improved the components of the toolkit as more cost-effective technologies have become available.

As well as providing access for nearby remote students the toolkit can be connected to the internet using any available Wide Area Network (WAN) link, such as an ADSL broadband connection, a 3G mobile broadband modem, or a Broadband Global Area Network (BGAN) terminal (see Section 4). Having connected to the internet anyone online can get remote access to the field location and the field workers can also access anything on the internet (subject to the bandwidth available over their WAN link).

In this paper we give an overview of related work, introduce the toolkit we have developed, describe the objectives and outcomes of three recent trials, and discuss these with respect to mobile learning through fieldwork. While not replacing direct fieldwork teaching, the remote approach offers a significant opportunity to introduce fieldwork learning to more students, to improve access to fieldwork, and to give fieldworkers improved access to online resources and collaborators.

2 RELATED WORK

In May 1991 the Wireless Coyote field trip was one of the first examples of the use of a wireless network to support fieldwork learning (Grant 1993). This involved 21 (6th grade) secondary school students working at Sabino Canyon in five groups: three groups of three students collected field data; one group of six students coordinated the data collection at a field base; and one group of six students at a school who collated the data and associated photographs and video clips to illustrate the dataset. Wireless Coyote used two-way radios for communication in the canyon. (Grant 1993) reports that analysing the data immediately, in the context of the canyon, helped the students relate the numerical data to their physical environment.

A more recent example of the use of a temporary wirless network to support data collection and analysis is the Virtual Environments for Research in Archaeology (VERA) project at Reading University [1] (Warwick et al. 2009). In this case, a wireless local area network is set up each summer at the Silchester archaeology dig site. As artefacts are uncovered they can be recorded and classified immediately using mobile technologies, such as digital pens and PDAs. Throughout the dig, the database of artefacts is updated and used to further support interpretation by the field researchers.

The Remote Accessible Field Trips (RAFT) project explored the benefits of students in schools accessing field trips through live participation over a communications link (Bergin et al. 2007). In separate trials different technologies were explored for sharing information, such as video conferencing for expert-interviews by the Canadian partners and data file transfer with students assigned to roles (e.g. a data gatherer, field communicator, and analyst) by the Slovakian partners. It was found that RAFT provided an engaging and motivating learning experience, in addition, the use of roles helped to motivate the students, and the field and classroom students had similar levels of participation and interaction when using video conferencing.

These examples illustrate the potential and versatility of applying standards compliant mobile and wireless network technologies to support fieldwork. We have developed a portable communications toolkit that can be used in a range of mobile learning contexts. Building on these examples we have tailored our tools to support a problem based learning approach where tutors act as facilitators to help students understand and solve practical problems in authentic contexts. To this end we have prioritised support for audio communication (using VoIP) and used visual communication tools (both live video and stills photographs) to support the dialogue between learners.

3 PORTABLE WIRELESS LOCAL COMMUNICATIONS TOOLKIT

In the ERA project we use standard (802.11b/g/n) wireless network access points to provide local WiFi coverage, and point-to-point links between the field tutors and remote students. Using a netbook computer as a server we run XAMPP services (specifically the Apache web server, MySQL database, ProFTP file transfer server, and PHP script language). We also run a VoIP server (namely, Asterisk) on the same machine which acts as a telephone exchange handling calls between people on the network.

A wireless digital camera is used to take photographs which are sent by the camera to the server using the WiFi network and the FTP (File Transfer Protocol) service. IP based security cameras and IP video encoders are used to generate compressed video streams, which can also be accessed using a web browser by anyone on the network. Students and tutors use netbook computers and smartphones (such as the Google Nexus, HTC Desire or iPhone) as client devices to view the photographs and video streams from the server in a standard web browser (see Figure 2). VoIP softphone applications (such as Twinkle, Ekiga, or Sipdroid) are used for making voice calls by the students and tutors on the same devices (see Figure 3).

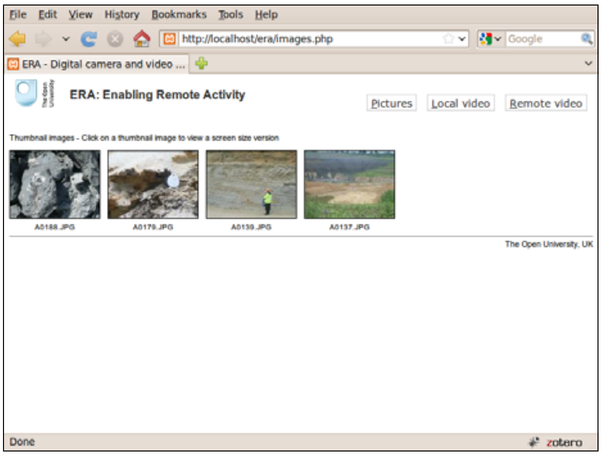

Figure 2. Example screen image showing four photograph thumbnail images. When more pictures are uploaded they are added to the page at the start of the list of thumbnail images (top left). To view a full-size picture the student clicks on a thumbnail image. The three links at the top right of the web page are used to switch between the pictures and live video streams.

The network access points are waterproof and are powered from external laptop batteries (placed in waterproof drybags). The access points are mounted on (lightweight) lighting stands and are placed at appropriate points throughout the field site to ensure connectivity between the field and remote locations (see Figure 4).

[1] VERA project website http://vera.rdg.ac.uk and blog https://vera.rdg.ac.uk/blog (last accessed June 2010).

Figure 3. An example of a netbook's in built web camera and VoIP softphone being used to show a remote student some details from a field site.

Figure 4. An example of a field location using a WiFi router on a lighting stand to provide a link to the field geologist at the top of the hill.

4 BACKHAUL OPTIONS

Internet connectivity is provided over a WAN link, which can be used to access online resources and collaborators. Three options are considered applicable for this:

- ADSL (Asymetric Digital Subscriber Line) broadband phone line,
- 3G mobile broadband modem, and
- BGAN (Broadband Global Area Network) satellite link.

The suitability of each option is dependent on the location of the field site. An ADSL broadband connection is the least expensive option and typically provides a better data rate than 3G or satellite links. Within the UK, the majority of homes and businesses have some form of ADSL broadband link. However, these are not often accessible from fieldwork locations. So, although this can be a preferred option where available, it cannot be taken for granted.

Third generation (3G) mobile broadband links typically provide a lower data rate than ADSL, but depending on the coverage of the corresponding mobile phone network they can be a valid alternative. For short term use in fieldwork locations the data rates are not prohibitively expensive. Again, network coverage cannot be assumed. A selection of SIM cards for a range of network providers can be tested in a given location in order to select the fastest.

Satellite terminals (such as BGAN) have a significant equipment cost and the ongoing data rates are expensive when compared to ADSL or 3G mobile broadband (see Table 1). However, the network coverage is extremely good and can generally be relied on. The data rates (on standard data tarrifs) are comparable to mobile broadband. Although expensive, satellite links are reliable and in a critical situation can be an essential backup option.

Table 1. A comparison of the data rate and pricing of internet connections (based on UK services in June 2010).

	Backhaul link option		
	ADSL [2] phone line	**3G [3] mobile broadband**	**BGAN [4] satellite link**
Typical UK data rate (max)	512Kbps (up to 20 Mbps)	512 Kbps (Max download speed: up to 7.2 Mbps. Max upload speed: up to 2.0 Mbps)	256 Kbps (Max download speed: up to 464 Kbps. Max upload speed: up to 448 Kbps)
UK pricing	£15.99 per month (Min 12 month contract) Data max 10GB per month	£29.99 dongle (includes SIM card and 1GB) Data £10 per GB	£2,500 terminal SIM card £500 Data £411.25 for 52 MB (£7.91 per MB)

Table 1 shows the typical (and maximum) data rates and the current pricing (based on UK services) of ADSL, 3G and satellite links. The actual data rates vary according to the network load, but one point worth raising is that the 3G mobile broadband networks typically shape the data rate delivered to each device into bursts. That is, the data rate is higher for

[2] Example taken from British Telecom 'Just Broadband' offer http://www.productsandservices.bt.com/consumerProducts/displayCategory.do?categoryId=CON-TOTAL-BB-R1 (last accessed June 2010).

[3] Example taken from 3 'ZTE MF112 Pay As You Go + 1' http://threestore.three.co.uk/payg/?modem=1 (last accessed June 2010).

[4] Example taken of 'Inmarsat Prepaid Airtime' from Satphone http://store.satphone.co.uk/Catalog/Inmarsat-Prepaid-Airtime (last accessed June 2010).

the first few seconds of each data request, when used for email and web browsing this gives a good level of service, but is less effective for longer data downloads, such as data files and video streams.

5 FIELD TRIALS AND EVALUATION

The recent developments of the remote activity toolkit have been motivated and informed by three trials during the last year. At a one week OU residential school at Durham (UK) in August 2009, we carried out a set of field tests working with OU tutors and students. This focused on improving the configuration of the local wireless network and support for VoIP telephony. As part of a two week EarthWatch[5] field trip in February 2010 to Masaya Volcano (in Nicaragua) we explored backhaul connectivity from the volcano to the OU for VoIP telephony, live video and photograph sharing. In June 2010, in collaboration with researchers at the Experiential Learning Centre of Excellence in Teaching and Learning (ELCETL), we ran an evaluation trial comparing direct and remote fieldwork with lecturers and students from the University of Plymouth at Devon Great Consols Mine. The following subsections describe each of these trials.

5.1 DURHAM

Alongside a one week residential school in Durham, four ERA researchers spent a week field testing and developing the local wireless network configuration and VoIP services. At the beginning of the week we worked at two separate field locations to explore the suitability of VoIP and video to support remote access for one of the OU courses. After further tests at other field locations, we finished the week by working with a demonstrator and tutor to help a group of eight mobility impaired students to complete part of the course using the remote access toolkit (see Figure 5).

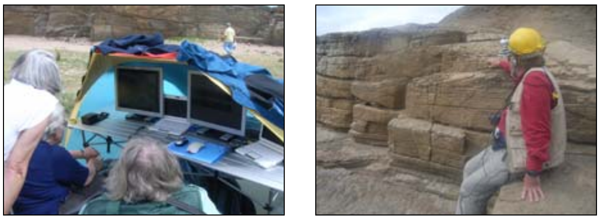

Figure 5. Remote fieldwork set up at Howick Haven (part of the Durham residential school in August 2009).

During this set of field tests we refined our use of the wireless network access points in order to maximise the data rate across the network. We generally use a linear network topology to link two (or more) locations (see Figure 6). By wirelessly connecting two access points we create a wireless link. If needed, we can connect two links together using an Ethernet cable and set the two links to different radio frequency channels (e.g. channel 1 and channel 6) to avoid any radio interference. In this way we are using two access points to create a radio repeater: one to receive the data and the other to transmit it. If we were to use a single access point to act as a radio repeater we would halve the data rate every time we added another link to the network. This is because the single access point would have to both receive and then transmit each item of data using the same radio transceiver.

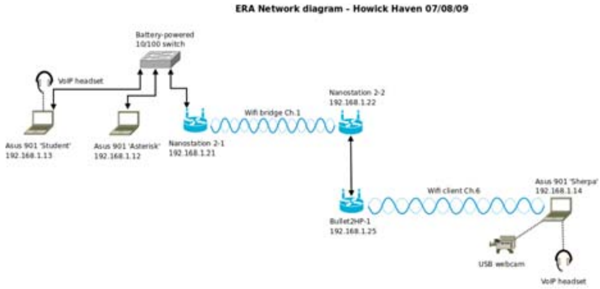

Figure 6. A typical network configuration used during the Durham field trials.

We used the Asterisk VoIP server with Ekiga and Twinkle softphones on netbook computers. Ekiga softphones had the advantage of also supporting video calls using either in built or external web cameras.

The feedback from the staff and students was very encouraging, for example:

> "I got a lot of information about the rocks - probably more than I would have done with my own observations" (residential school student).

Using the above network configuration, we consistently achieved local data rates of around 15 Mbps throughout this set of trials. The VoIP service performed well over the network. In several locations we did have problems seeing the screen in bright sun light, and a cover to provide shade alleviated, but did not solve this problem. Suggestions for improvements to the system included ways of tracking the tutor's location or marking the locations of interest on a map of the field site, in order to help orientate the students and improve their sense of the tutor's position. Further details of the Durham trial are available on the Portable VoWLAN blog site http://projects.kmi.open.ac.uk/era/vowlan (last accessed September 2010).

5.2 NICARAGUA

In February 2010 one of the ERA researchers joined a team of OU volcanologists for two weeks, as part of a six week EarthWatch field season at Masaya volcano. During our two week field trip we planned to test the potential backhaul internet links from the volcano to the OU. During the preparation for the trip we tested ADSL broadband, 3G mobile broadband, and BGAN satellite connections in the UK. This helped to guide the researcher in the use of the equipment and develop their fault finding techniques. We had already arranged to make use of the hotel's cable broadband connection during the trip, identified potential sources for purchasing 3G SIM cards and mobile broadband USB dongles near Masaya, and checked with our BGAN terminal supplier to ensure the Inmarsat SIM card and credit would be suitable for use in Nicaragua.

[5] EarthWatch field trips to Masaya volcano in Nicaragua involve OU researchers http://www.earthwatch.org/exped/rymer.html (last accessed June 2010).

We were unable to source a 3G broadband SIM card or USB dongle in Nicaragua, although advertised online they were only recently released and were unavailable in the Masaya region at the time of the trip. The hotel ADSL link was comparable to that available in the UK and supported file transfers as well as Skype voice and video calls. The BGAN terminal also performed well, and was used on the volcano to send photographs and live video back to the OU, and to make two-way VoIP calls (see Figure 7). Further details (including clips of photograph downloads, video streaming and VoIP calls) are available on the Portable WLAN blog http://projects.kmi.open.ac.uk/era/jawlan/?p=414 (last accessed June 2010).

Figure 7. ERA local network, IP video camera, web server and clients used in Nicaragua.

5.3 DEVON

In June 2010, in collaboration with the Higher Education Academy's Geography, Earth and Environmental Sciences Subject Centre (GEES), and the Experiental Learning Center for Excellence in Teaching and Learning, we ran an evaluation trial at Devon Great Consols Mine. This involved two of the members of the ERA team, and two lecturers, a researcher coordinator and a research officer from the University of Plymouth. Over two days we ran two half-day remote fieldwork trips and two half day direct fieldwork trips. Each field trip involved around 10 undergraduate students studying GEES subjects at the University of Plymouth.

The focus of the evaluation trial was to investigate cognitive and affective learning in remote and direct fieldwork. The teaching involved two lecturers taking the students on a tour through a mine and asking them to complete an Environmental Impact Assessment activity (see Figure 8). In the direct fieldwork sessions, the students worked alongside the two lecturers in the field, and in the two remote sessions the students stayed in the car park at the mine with one tutor. They spoke to the other tutor (as a single group) using a VoIP phone with a loudspeaker that everyone could hear and a single shared microphone. The tutor's tour was watched by the students on a single 24-inch LED screen, which displayed a live video stream from a camcorder connected to a video encoder carried by the research officer.

Figure 8. ERA evaluation trial at Devon Great Consols Mine. The remote students and tutor (left) work with the field tutor and camera person (right) to complete a half-day Environmental Impact Assessment (EIA) scoping sheet activity.

A pre and post questionaire was completed by all of the students, and a 40 minute focus group was held with each of the four groups after the fieldwork was completed. The analysis of this data is ongoing and will be presented at the conference, but the initial findings are generally positive. Unlike in the previous two trials where we used the network to provide a point-to-point connection between the remote students and discrete field locations, this trial required us to set up a continouous network throughout the mine area (covering about two square kilometers). As this was also a previously unused site it required some field testing (on the previous day) to identify suitable positions for the network access points.

From a technical point of view, the system performed well, but of particlar interest to us was the use made of the toolkit by a different set of lecturers. The teaching mode followed an active approach that involved the students and tutors in a discussion of the site (in both the remote and direct sessions). Surprisingly, the video camera and VoIP call were used exclusively. Although available (and verbally prompted) the students did not request any photographs to be taken. This contrasts with the use made of the toolkit on OU geology courses where both video and still images are used extensivly. This difference could be due to subject differences between geology and environmental science. Further information on the evaluation trial is available on the Portable VoWLAN blog site http://projects.kmi.open.ac.uk/era/vowlan (last accessed June 2010).

5.4 SUMMARY

Throughout the three trials we have adopted a participatory approach to development involving both teaching staff and students. The ERA toolkit has been developed iteratively over successive trials and applications, both in terms of the technology used and teaching approaches that have been explored. Table 2 summarises the approach, technology used, teaching mode and outcomes of the above trials.

6 DISCUSSION

In developing support for both nearby and distant remote fieldwork a number of trade-offs are evident. One is the trade-off between network type and data rates, specifcally the distinction between a local area network (as used in nearby remote fieldwork) and a wide area network (necessary for distant remote fieldwork). As network technology and the relevant infrastructure systems improve the data rates available on local and wide area networks will increase. Nonetheless, this is unlikely to improve dramatically in the next five years.

The data rates currently available in a local area network can support two way (full frame) video and multiple voice calls, as well as photograph sharing and other data. When using a wide area network connection (such as a 3G or BGAN link) the lower data rates means that the quality of thie video image should be reduced. For example, when we used a BGAN satellite in Nicaragua we found it necessary to limit the data rate for the video to 200 kbps, a half or quarter size video at lower frame rates (such as 5 frames per second) are possible at this data rate. We have been using MPEG-4 (hardware) compressed video streams, h264 video is an aternate format that could offer better compression and thereby the possibility for a better quality video stream at these lower data rates.

Table 2. A summary of the three trials highlighting the approach, technologies, teaching mode and outcomes.

	Trial		
	Durham	**Nicaragua**	**Devon**
Approach	Nearby remote access	Distant remote access	Nearby remote access
Technology used	Local WiFi, VoIP, video, photos	BGAN satellite link, VoIP, video, photos	Local WiFi, VoIP, video
Teaching mode	Sherpa and tour guide	Sherpa and field research	Tour guide
Outcomes	Photos, VoIP and video over local network point-to-point	Photos, VoIP and video over BGAN point-to-point	VoIP and video continuous throughout site (photos not used)

Voice services are another example of time critical data. In this case the size of the data packets being passed are quite small (16 kbps), but any delays in the network can lead to the audio breaking up and becoming uninteligable. Therefore, the quality of the network connection is important not just in terms of the data rate, but also the number of lost packets. We have found the local network configuration described in Section 3 to be effective for VoIP. As noted above we have also used VoIP over 3G and BGAN connections. In these cases we have been using the Speex audio codec, improvements in the audio compression algorithms (as with the video codec) can lead to improved quality at similar data rates (or comparable quality at lower data rates).

Another trade-off relates to the resolution of still photographs and the speed of downloading them over the network. Larger resolution images generally result in larger image files which take longer to download. We use JPEG images at a resolution of 1280 x 960. The corresponding images files are usually between 350 KB and 800 KB (depending on their content) and only take a second or two to download.

In the work to date we have focused on giving remote access to individual or small groups of students. In order to work effectivley with larger groups it may be necessary to use a multicast service (such as a Shoutcast server or Wowser Media) to recieve and rebroadcast data from the field site. Such services provide a technical solution to scalability, but in addition to this the social dimensions of large group interactions need to be taken into account when designing remote access at a larger scale. For example, voting polls, text chat or email may be more effective than audio calls for supporting live communication when more than two parties are involved.

The ERA toolkit offers a range of communication options, as with many mobile learning platforms the appropriate selection these tools depends on the nature of the activitying being undertaken and the form of network connections available.

7 CONCLUSION

We argue that direct fieldwork versus remote fieldwork is an unfair comparison. As with many technology mediated activities remote and direct fieldwork are different activities. The costs of introducting technology needs to be outweighed by the benefits realised through its effective use.

Fieldwork helps to contextualise a student's knowledge or the knowledge shared within a fieldwork group. The remote fieldwork experience improves the accessibility of fieldwork and enables more people to activley participate in fieldwork. Distant remote fieldwork extends such an opportunity for anyone to access fieldwork events over the internet, and for fieldworkers to consult online resources and colleagues at apropriate times during a field trip.

8 ONGOING WORK

Two activities related to this work are ongoing: the analysis of the Devon evaluation trial data, and the application of the ERA toolkit in the EPSRC funded Out There and In Here (OTIH) project. The analysis of the evaluation data will help us to further understand the distinctions between direct and remote fieldwork. In the OTIH project the use of a large multi-touch display in a lab is being investigated as a means to collate and coordinate fieldwork at a distant field site. Trials in the OTIH project will be ran in August and September 2010. We will are planning to use a 3G mobile broadband internet link with a wireless local area network to support remote collaboration between a group of students in a Buckinghamshire sand quarry and a group of students at the OU.

ACKNOWLEDGEMENTS

We would like to thank JANET and JISC for supporting the ERA project. JANET's Portable WLAN Programme funded our trials investigating the use of alternate backhaul links and refining the wireless local area network configuration. A JISC Rapid Innovation grant enabled us to develop the use of VoIP telephony over the portable wireless network. A further JISC benefits realisation grant has enabled us to collaborate with researchers at the University of Plymouth to carry out the evaluation trial in Devon Great Consols Mine. We would also like to thank the students, lecturers, tutors and researchers that have worked with us to improve the toolkit.

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Technologies

Full Papers

Mobile post-training support in a South African health environment using the open source platform MLE

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Abstract
This paper presents a case study on the implementation of a mobile platform for post-training support as part of the HISDC (Basic Health Information Systems for Data Capturers) programme of the National Department of Health in South Africa. The implementation was built around the MLE (Mobile Learning Engine) an open source mobile learning tool. After a description of the project and the MLE tool/platform, Actor-Network Theory, and specifically, Callon's notion of *translation* is used to show how the phases of *Problematisation, Interessement, Enrolment* and *Mobilisation* are negotiated by the *primum movens* (in this case the service provider) to establish a successful mobile post-training support network. The MLE proves to be a successful tool for mobile post-training support in this particular environment.

Keywords
Mobile Learning Engine, ANT, mobile learning

1. INTRODUCTION
The critical need to improve health information in South Africa gave rise to the Basic Routine Health Information System for Data Capturers (HISDC) project. This project involves the training of 3535 unemployed youth as Data Capturers over a period of three years. The National Department of Health identified the need for such a project in February 2007 where after a task team was formed to develop a concept document. In April of 2007 the concept document was adopted and added to the Presidential Priority List for the EPWP (Expanded Public Works Programme).

The aim of the Basic Routine Health Information System for Data Capturers is not only to improve health information across South Africa but also to secure the Human Resource supply in the public health sector. In achieving these aims the project also provides unemployed youth with the opportunity to obtain invaluable training and working experience.

In November 2008, the NDOH awarded the tender for the 3535 project to the services of a collaborative team namely Health Information Systems Programme (HISP), Health Systems Trust (HST) and Continued Education at the University of Pretoria (CE at UP) . The training programme involves 21 days of full time training at the Hammanskraal Campus of the University of Pretoria for groups of approximately 140 learners at a time. The training covers:

- Computer Literacy
- Health Information Systems
- Data Management
- District Health Information System (DHIS) Software
- Electronic Tuberculosis Register (ETR.net) Software

After training the completion of the training, learners are transported back to their rural and urban health facilities to serve as data capturers for the remainder of their on year internship.

As part of the agreement between the client and the service provider; post-training had to be provided. Initially this support was to be done telephonically and a share call facility was set up for this purpose. In addition the service provider offered to provide mobile post-training support as an "add on" to the helpline support originally specified by the Department. Mobile support was done via the MLE and linked to this was a targeted SMS service. The reasoning behind the mobile support option was the fact that South Africa has an extremely high cell phone penetration (above 95%) and this was seen as the most effective way of keeping in contact with the learners. This has indeed been confirmed by the fact that in each group of 140 learners, on average, only one or two persons do not have a mobile phone.

A special session is arranged during each course – specifically devoted to post-training support to provide information on the helpline and the mobile support system. During this session learners are provided with airtime vouchers which are sponsored by the client. Learners are also asked to complete a basic "Mobile Learning questionnaire" - to determine their previous experience of mobiles (SMS; browsing the Internet; mobile banking; IM; mobile learning). Learners are also shown how to choose the best option for their particular handset.

The aim of this paper is to describe the implementation of the mobile post-training support system for the project; specifically the use of the open source MLE and its usefulness as a mobile training tool in a post-training support health environment over long distances in South Africa.

After a description of the MLE open source platform; Actor-Network Theory will be used to describe its implementation within the project, tracing the negotiations and establishment of the relations which eventually led to a fairly stable mobile, black boxed post-training support solution.

2. MLE (MOBILE LEARNING ENGINE)

2. 1 MLE

According to the official MLE website it "is a comprehensive learning application... which transfers computer-aided and multimedia-based learning to a mobile environment... The MLE enables the student to use his (sic) mobile phone as a medium for learning."(MLE - Webmaster 2010)

2.2 Components

The MLE consists of three different software components which allow for content creation, delivery and access, detailed on the website as follows: (MLE - Webmaster 2010)

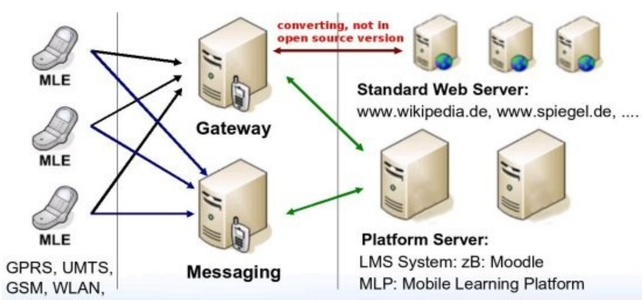

Figure 1: MLE Component

2.2.1 The Mobile Client (MLE Itself)

"The actual Java application (J2ME) which runs on the mobile phone. It is the end-user user-interface which runs on the mobile phone. If people speak of the MLE they mean this software part: the mobile client." (MLE - Webmaster 2010)

For the project implementation, the MLE client was renamed MOBI and adapted by changing icons and also adding functionality which was not present in the original version, such as the ability for learners to communicate via IM in groups rather than just one-on-one. In addition, the adaptations were also required given that many learner phones would not be able to run the J2ME application (cf Figures 2&3).

Figure 2: MOBI Start Page

2.2.2 The Gateway and Messaging Server

"These two Java servers (J2SE) are installed on a standard server with Internet access. They are used by the mobile client to access the Internet in a more efficient way and for instant messaging." (MLE - Webmaster 2010). Access to the system is controlled by registration with one's ID number as the primary key, since most learners have more than one cell phone number (in this way maximising benefits from different providers' pre-paid offerings)

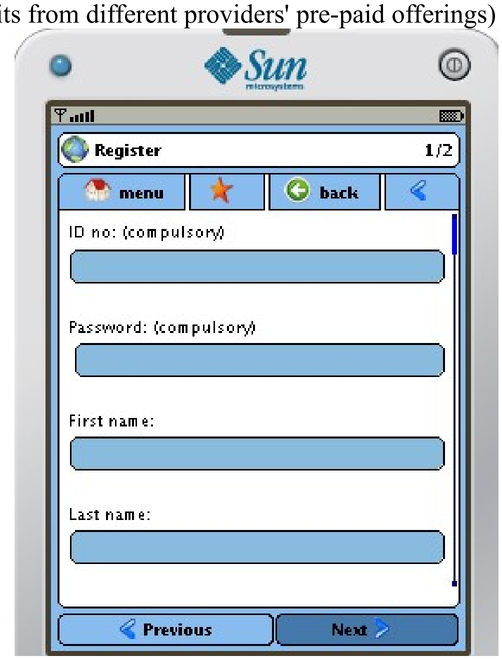

Figure 3: MOBI Registration

2.2.3 MLE Editor

This is a WYSIWYG (What You See Is What You Get) - Editor to create content (whole content packages) for the mobile client. This might be just some formatted text with images or a whole learning-object with interactive questions. This editor was designed for people with no XML experience. The idea is to make the implementation as easy as possible for non-specialists.

For the purposes of the HISDC project, a dedicated MLE server was set up and the MLE was modified and renamed MOBI. Even though the MLE allows for Moodle integration this was not implemented since the focus was on post-training support only. It should be mentioned at this point that, similarly, for the telephonic helpline support a dedicated share call facility was set up.

3. ANT AS FRAMEWORK FOR DESCRIBING THE MLE IMPLEMENTATION

In the past decade or so, Actor-Network theory (ANT) has become increasingly popular in IS research - often related to case studies of ICT implementations. (Tatnall 2003; Mähring et al. 2004; Macome 2008; Law & Hassard 1999; Doolin & Lowe 2002; Walsham 1997)

Actor-Network Theory originated in the work of Callon (Callon 1986b; Callon 1986a), Latour (Latour 1993; Latour 2001; Latour 2005) and Law (Law & Hassard 1999; Law 1992; Law 1986b; Law 1986a; Law 1991). It "tries to trace and explain the processes whereby stable networks of aligned interests are created and maintained"(Rhodes 2009) and concerns itself with describing heterogeneous networks and the relations that hold these together. In the words of Law "Actor-Network theory is a disparate family of material-semiotic tools, sensibilities and methods of analysis that treat everything in the social and natural worlds as a continuously generated effect of the webs of relations within which they are located" (Law 2007).

Crucial to an ANT understanding of the world is that no *a-priori* hierarchical distinction is made between humans and non-humans (animals and inanimate objects) within a network – especially not in terms of agency. In other words, all objects within a network, human and non-human are treated equally in writing up the "narrative" of a network in a sociology of *associations* (Latour 2005, 63-86; 159ff).

All objects within a network are seen as *actors* each with agency and the ability to influence and determine the stability or instability, success or failure of the actor-network (Callon 1986b; Callon 1986a).

In order to describe the interactions and relationships within a stable or failed (attempted) actor-network, Callon developed the notion of translation which involves four moments; *Problematisation, Interessement, Enrolment* and *Mobilisation* (Callon 1986b). See also (Latour 2001, 103-144). "These moments constitute the different phases of a general process called translation, during which the identity of actors, the possibility of interaction and the margins of manoeuvre are negotiated and delimited" (Callon 1986a, 203).

It is this notion that makes ANT particularly attractive as a framework for the case study because it provides an ideal way of dealing with the roles, relationships and interactions that the different entities enact in establishing the "not-finished-yet-but-stabilising" post-training HISDC MLE/MOBI network. The implementation of post-training support for the HISDC project is an example of an attempt by the service provider to establish an actor-network, wherein at least the following actors play a role; NDoH, learners, service provider, mobile platform (MLE/MOBI), Cell phone/data network, fixed-line network, learning content and local health facilities.

By setting up the post-training support as described, the service provider is essentially attempting to establish a new actor-network that will enable it to continue its training relation with the learners once they leave the training facility. The success of which will be determined by the service provider's ability as the "primum movens" to get the buy in of the other actors (including the learners and the technology) in this (yet-to-be) network.

We now take a closer look at how the different phases of translation play out during the implementation of the post-training process following the "narrative" lead of Callon, Latour and others.

3.1 Problematization

While the learners are still undergoing their training, they are introduced to the idea that when they leave they will need and require post-training support. This is the problematization phase of the yet-to-be established actor-network. During the training phase the provider's position is fairly entrenched – but the same cannot be said for post-training. In order to maintain a relationship with the learners during post-training some mechanism needs to be put into place.

The learners are then introduced to the two means by which post-training will take place – a telephonic help line and the mobile platform/application. As an incentive, learners are provided with "air time" to be used specifically for the purposes of post-training support. To strengthen this incentive is the fact that the learners who actually make use of the system by logging in are rewarded with more air time vouchers as the time passes.

From an ANT perspective it is clear that the service provider, by setting up this session on “post-training support” and introducing the two enabling technologies, is essentially trying to extend its power and set itself up as *indispensable* during the post-training phase (Callon 1986a, p.203).

Essentially this is about establishing “long distance control” or at least some measure of it, not unlike the Portuguese vessels which John Law writes about (Law 1986a). Similar to the Portuguese in Lisbon trying to manage events half-way around the world, the service provider needed to control learners in the remotest health clinics of South Africa. This is obviously in its interest as it is a specific requirement from the client that sufficient post-training support is provided.

The set up of the post-training support brings the following actors immediately into the equation: the client as project sponsor, the service provider, the learners, the distances between the provider and the learners and the lack of established communication channels as well as the technologies (mobile and fixed line). In order for post-training to happen, these actors need to be in alignment – what Callon (Callon 1986a, pp.205-206) calls the OPP (Obligatory Passage Point) needs to be reached. Therefore the situation that needs to “occur for all the actors to achieve their interests” (Rhodes 2009, p.5), specifically as (re)defined by the primum movens.

The client requires post-training and the service provider states its need for post-training support to happen as something which is in the interest of the learners. If the learners opt in to this narrative and it is supported by the relevant technologies alignment takes place and post-training support happens successfully; the OPP has been reached.

3.2 Interessement (Getting Actors to Accept Framed Roles and Relationships)

Problematization is essentially an attempt from a macro-actor to enlist other actors into achieving a common goal. However, defining a problem and the interests of others in overcoming it is not enough. This is due to the reason that actors are often part of more than one network, with other actors and networks also attempting to enlist them.

A successful network will only be established if the macro-actor is able to weaken the ties between the actors it is trying to enlist and their existing or potential networks. For instance, once the learners return to their different workplaces it is quite possible that their ties with these entities and the networks in which they then find themselves will be so strong that they refuse to still adhere to the role of learners. In such an event the post-training support will collapse; since the problematization as formulated by the service provider will lose its attraction.

This is where the second moment of translation becomes essential. “Interessement is the group of actions by which an entity... attempts to impose and stabilize the identity of the other actors it defines through the problematization” (Callon 1986a, pp.207-209). For example; arranging the session on post-training support, having the learners register on the mobile support database and making the help-line a share call facility all constitute actions designed to initiate, strengthen and keep in place the ties with the learners within the post-training support network – *before they leave* for their respective health care facilities. Similarly, by setting up a separate server for the HISDC implementation of the mobile learning platform (MOBI) – rather than being just another instance of an e-learning project running off an existing server - the service provider ensures that it was enlisted solely for its purposes.

From the client side, the post-training network was ring-fenced simply by making it a deliverable with milestones within a larger project against which payments occur and demanding a minimum availability of facilitators. By doing so the client has again ensured that all links that the service provider and its members have with other networks would at least be weakened to such an extent that the post-training would be prioritised. This was obviously done as part of the setting up of the project as a whole.

Viewing the client, the service provider and learners as actors is not so difficult, but how does this apply to the technology – in what way is it an actor? The telephonic help line *acts* by enabling two-way communication between learners and the service provider. Similarly the mobile tools *act* by allowing learners to access content, post questions, set up social groups on the one hand and allowing the service provider to add content, answer questions, moderate discussions, etc on the other hand. As long as these technologies allow for post-training communication to take place their existence within the post-training network is guaranteed – but as soon as any of these technologies is not involved in this process – for whatever reason – it will be sidelined and its existence within the network will be threatened.

It should be noted that the service provider (or its client) does not really care about which technology enables the post-training support to take place – as long as at least one of them enables this. The continued participation of the technological actors of the network is dependent on the extent to which the service provider is able to arrange and stabilize their relationships. (These can be achieved through things like, ensuring access, ease of use, availability, etc.)

The continued participation of the learners is dependent upon whether they perceive any value in the relationship, either by keeping in touch with one another, the service provider or even the client.

3.3 Enrolment (Redefining Roles and Relationships)

Once the training ends the learners leave for their respective health facilities all over South Africa some urban and some rural. The dominant position that the service provider has at the training venue is no longer relevant. It is now time to see if Problematization and Interessement were sufficient. Does enrolment take place? Are the learners willing to engage in the post-training network? Does the technology support post-training? Are alliances formed? Do the various actors work together as in a stabilized environment? The answer is “Yes” - and “No”. The telephonic helpline fails completely while the mobile platform succeeds.

The success of the mobile platform is quite surprising for some because a questionnaire completed during the “Post-training support session” indicates overwhelmingly that learners have no prior experience of e-learning, mobile learning or even access to the Internet via cell phone. From this perspective the odds are against it succeeding. Nevertheless, it seems that the attempts of the service provider have not been in vain – a successful post-training support system has been established – at least as far as MOBI is concerned. Over 70% of learners register on the mobile platform, they access learning content from their mobiles even though they have printed versions, they post hundreds of questions on the FAQ section, they engage with the mobile platform thousands of times.

The telephonic helpline fails. It is hardly ever accessed, despite the fact that it provides immediate gratification as opposed to the mobile platform where answers are provided asynchronously. Rural and urban learners, male and female alike embrace the new mobile technology enthusiastically and to the detriment of helpline. Perhaps it is because of a fear of direct contact, of being “caught out”, or perhaps the cost implications – share call does not kick in if a number is called from a mobile phone. Whatever the case is the fact remains that the post-training solution initially suggested by the client fails dismally. Given a choice, it seems learners prefer the mobile environment.

3.4 On the Road to “Black Boxing”

Within an Actor-network theory a stable network is referred to as a black box. The term indicates the use of a technology or the acceptance of a system, where one no longer asks questions about the complicated network or its participants. It is a network in which the relationships have become stable, with each actor playing its part without pushing the boundaries (Latour 2001, pp.1-15). Clearly success for the service provider would mean a stable “black boxed” system. At this stage of the project (about half-way through training the 3535 learners) it seems that some stability has been reached, but not without a certain level of re-negotiation of relationships taking place along the way.

The mobile system endures, however on its way to being black boxed, it is transformed, roles and relationships change. It was designed in a specific way, it was set up as a post-training support technology with specific aims – but the learners use the technology in unexpected ways. For instance, the FAQ section becomes a forum not only for course/training related questions, but for all kinds of issues, including employment issues, working conditions and personal issues. As a result, the service provider has to adapt the interface to split the FAQ's section into two. One relates to training issues, and the other to general and employment questions.

However, this now has further implications – the original system did not require client input at all, it was built entirely on the premise that the service provider would be able to answer training-related only questions. As a result of the learners' influence, the system has now changed to the extent that a mechanism needs to be set up to enable feedback to the client on issues which are raised on the platform that have nothing to do with the service provider's mandate and even to find ways of having the client respond.

The network which is established becomes more than a post-training support system with a focus on content and learning. For the learners it becomes a general information and communication tool. Even the client is “coerced” by the evolving MOBI platform as it starts using it as a tool for communicating with the learners on other issues not related to the project itself, even to the extent of becoming an “advertising tool” and database used in other projects.

By the time that the post-training support actor-network becomes stabilized, it is quite different from the one which was originally conceptualised. Instead of a vibrant help line supported by a mobile platform the roles are reversed and even the mobile platform becomes something different from what was originally envisaged. The changes are a result of the learners refusing to accept their roles as being learners only within this network. When the learners engage with the post-training system, they bring with them their network ties to their workplace, employer and community.

The initial problematization - although apparently accepted - is adapted and expanded in such a way that enrolment takes place on different terms than the one-sided version envisioned by the *primum movens*. In all of this, the service provider is not powerless. Learners need results and getting results from the NDoH via their districts through the provinces is cumbersome. At least the information is available through MOBI without any other mediators.

3.5 Mobilization

Mobilization is about someone becoming a legitimate spokesperson for the actors in the network. It is about rendering the “entities mobile which were not so beforehand” (Callon 1986a, p.216). Following enrolment, mobilization is about representing actors at a specific time and place so as to ensure the continued existence of a network. In terms of this project; the service provider uses the system's database capabilities to gather usage information for reporting purposes. Together with the role of the actors in the project this serves to further legitimate them as spokesperson for the post-training network.

The following emerges – the mobile platform is accessed thousands of times during the first phase of the training with each learner, on average, accessing it 8 times in the first month after training. In the first part of 2010, during the second phase of the project it is accessed 6298 times between January and April. Hundreds of questions are posted (and answered) on the FAQ section. Despite the fact that learners have handbooks a significant number of queries are related directly to the online learning content. It seems that while learners are at work busy with data capturing, obviously without their learning material, it becomes an easy option to just use the mobile platform to revisit the learning material. Again, it is significant that they prefer this to making use of the telephonic helpline.

The learners are dispersed all over the country, they do not have a single unified voice, but by becoming their spokesperson the service provider is able to present a unified voice on their behalf; indicating the value that the mobile support platform has for them.

Active in this representation, in this mobilizing of the learners, is the technology platform. The database with questions and answers allows the service provider to narrate, on their behalf, the value of the system, not only for themselves, but also for the client. Indeed this is what happens; at a specific meeting the fate of the helpline is sealed and that of the mobile post-training support system is ensured; the learners are ensured that the system as it was co-created by them will remain in existence for the duration of the project – and perhaps beyond.

4. CONCLUSION

The HISDC project is a good example of how an open source tool such as the MLE can be utilized to establish a mobile post-training support system in an environment where learners are dispersed over large distances comprising of both urban and rural environments.

The advantage of the system being open source, obviously, lies in the fact that there is no direct capital outlay involved but even more so in the fact that it was quite easy and quick to adapt and change the system specifically for the needs of the project without having to create the client, server back-end and editor from scratch.

Tracing the various phases of *translation* from an ANT perspective allows one to become more aware of the interplay that happens between the various actors in the establishment of such a system. Moreover, from the ANT discussion, it became quite clear that the learners were not passive recipients of the system, quite the contrary, active participants in the creation of the system. A system that is now somewhat different than originally envisaged by the service provider.

This insight from ANT may be quite useful for other mobile learning projects. The learners were not supposed to be quite as powerful as they eventually became in the post-training support actor-network.

The post-training support for this project was envisaged initially as a twofold initiative, dominated by a telephonic helpline and supported by a mobile learning platform. As a result of various factors, not least the preference of the learners for the mobile technology – the telephonic helpline is being discarded, with the network stabilizing around the mobile platform.

Again, as a result of the specific way in which the learners acted in the utilization of the platform and its interface it was transformed from a mere content delivery platform to an interactive communication tool which now also looks at engaging the client – something which definitely was not part of the original system.

Overall, the case study represents a clear case where mobile post-training support was more successful than telephonic helpline support. As such the case study provides useful insights for similar projects aimed at utilizing mobile learning in a developing context.

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Global Mobile Learning with Games Consoles

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Abstract
This paper looks at the use of games consoles to provide mobile language support for students abroad on exchange programmes. It describes an on-going project in the UK, funded by JISC using the Nintendo DSi, one of the World's mostly widely used games consoles. Third year students of the University of Edinburgh who are spending a year on exchange at a Japanese university are using the DSi as a mobile language learning platform . By using wifi to link the DSi to the internet, students are using *Ugoku Memocho* (Flip Notes), a free service allowing Nintendo DSi users to create and exchange simple animations, to practise drawing Japanese characters, record spoken sentences, listen to the recorded voices and share them with their fellow students and their tutors on the course website. The course tutors in Edinburgh provide students with language exercises on a regular basis and the students are expected to post their responses back to their tutors.

The study has identified several technical, pedagogical and socio-cultural issues in using the DSi as a learning platform for remote students. It has also identified that the variation in tutorial participation has been influenced by the level of students' prior familiarity with the games console. This paper addresses the practical measures being taken to make learning experiences more effective and inclusive, examining how contingent context-sensitivity can be incorporated into such situated-learning practices.

Keywords
Language learning, Japan, activity theory, DSi,

1. INTRODUCTION
The Nintendo DSi is one of the world's most widely used games consoles. As well as playing games, DSi users can use it to access the Internet and social media using widely available WiFi connections. Games consoles are increasingly being used in Japan as low-cost mobile learning devices. This paper looks at a project at the University of Edinburgh that uses the DSi to deliver mobile language-learning for students away from the university on exchange programmes. This project (*HANABI: Handheld-device enhanced learning with Nintendo's applications beyond institution*), funded by Joint Information Systems Committee (JISC), is a pilot study evaluating the use of hand-held game consoles as a mobile learning platform. Drawing upon this on-going project, this paper looks at how games consoles in general, and the Nintendo DSi in particular, can be used in a year-abroad programme.

The distinctive aspect of the HANABI project is the linkage between the DSi, a free graphics application for the DSi (*Ugoku Memocho/* Flip Notes) and a free web service for DSi user collaboration, *Hatena.* The combination of these resources allows tutors and the students to create and exchange simple animations and images, practise drawing Japanese characters, record their speech, listen to the recorded voices and send them to another user's DSi. They can also share the user-generated content with their fellow students and their tutors using the course's closed *Hatena* website. The course tutors in Edinburgh provide their students in Japan with language exercises, which cover "writing", "reading", "listening", "speaking" and "vocabulary building", and the students are expected to post their responses back to their tutors as well as to the course website.

The paper first looks at the background to the practice and implementation of this project and then addresses the findings from the mid-term survey study conducted as part of the formative evaluation. Several technical, pedagogical and socio-cultural issues encountered in using the DSi as a learning platform for remote students will be highlighted. Finally, the paper discusses the measures being taken following this interim evaluation to make learning experiences more effective, inclusive and sustainable beyond the project's life and it examines how contingent context-sensitivity can be incorporated into such situated-learning practices.

2. THEORETICAL CONSIDERATIONS
In this study *activity theory* is being used to understand the students' practices in using the DSi for language tutorials. Remote tutorial sessions mediated by DSi reflect the cultural and societal nature of the activities and the analysis of them needs to be socially contextualised to reflect the complexity of the construction of such activities. Socio-contextualised studies of educational technologies, which have their roots in Vygotsky's

(1978) cultural-historical psychology, have been evolving for the past decades and have become increasingly significant.

Activity theory has been widely used for analysing the design of web-based e-learning, e-learning contents and hypermedia and distance learning experiments (Hung and Der-Thanq, 2001; Mwanza and Engeström, 2005; Giest, 2008). In the area of education, for example, the theory of situated learning (Lave and Wenger, 1991; Wenger, 1998 [2001]) has developed Vygotsky's perspective. However, there is a scarcity of studies using this perspective that look at the students' participation in e-learning/m-learning tasks and activities.

According to Leont'ev's version of *activity theory* (1974, 1978, and 1981), an activity can be analysed at three levels: *activities*, *actions* and *operations*. He developed a triangular model of action, which in this case allows us to gain insights into how language tutorial sessions using DSi can be designed and implemented to achieve the object of improving the language skills of remote students. According to Leont'ev's model, the central level / group of levels is that of actions. Actions are goal-directed processes to achieve the object. In this research context, actions are using DSi to participate in tutorial assignments provided by language tutors from the home institution. The goals of the actions should be improving a range of language skills: writing, listening, speaking, reading and vocabulary building. Usually, goals are functionally subordinated to other goals, which may be subordinated to still other goals. Goals are hierarchically structured, ranging from a set of simple tasks including vocabulary testing, short oral testing, but then expanding to composition and then to collaborative creative learning amongst dispersed students. The notion of "motive" plays a key role in the conceptual framework of *activity theory* (Kaptelinin and Nardi, 2006). In this case the students' principal motives should be learning and improving Japanese language and maximising their year abroad experience. Goals are the objects human activities are directed to and the object of activity, which is defined by Leont'ev as the "true motive" of an activity (Leont'ev, 1978).

In consciously directing their activities towards the achievement of goals the students may develop idiosyncratic activities and, as they become more familiar with the activities, their actions may become subconscious, like changing gears in a car. In *activity theory* terminology, these non-conscious actions are termed "operations" and, unlike *activities*, *operations* do not have their own goals. Thus, in *activity theory*, the activities are driven by conscious motives to achieve outcomes and lead to the performance of actions and operations. The actor will generally use artefacts to enact their activities and these artefacts therefore mediate between the goals and the actions, with the activities shaped by the affordances of the artefacts.

Engeström's model of the *activity system* (Engeström, *et al*, 1999 [2003]), was derived from the ones of Vygotsky and Leont'ev. *Activity system* reconciles a systemic view and the subject's view.

> *The analyst constructs the activity system as if looking at it from above. At the same time, the analyst must select a subject, a member (or better yet, multiple different members) of the local activity, through whose eyes and interpretations the activity is constructed. This dialectic between the systemic and subjective-partisan views brings the researcher into a dialogical relationship with the local activity under investigation* (Engeström, 1999 [2003]: 10).

Computers did not exist when Vygotsky laid the foundations of his approach (Rückriem, 2009: 88). The current activity-oriented concept of mediation, with its notions of tool, symbol, and artefact requires more careful considerations of the importance of digital technology since the use of social software and mobile devices, in particular, are making digital systems ubiquitous and taken-for-granted. This raises the issue of whether these independently functioning technical systems, like Facebook, are activity systems or simply tools (Weiser, 1991, Ruckriem, 2009: 91).

We argue that it is useful to analyse the tutorial activity as a system. Recent developments in activity theory (Nardi, 1996; Kaptelinin and Nardi, 2006) are of particular help in obtaining insight into the role of digital artefacts in our everyday existence and understanding the way artefacts are integrated into social practice. Nardi (1996) has described *activity theory* as a 'powerful and clarifying descriptive tool' and its object is 'to understand the unity of consciousness and activity' (Nardi, 1996: 4). *Activity theory* takes account of the constituents which construct human beings' consciousness which is located in our everyday life and it allows us to understand the transforming relationship between the individuals, other people and artefact in a certain setting by providing a set of perspectives on human activity and a set of concepts for describing that activity (Nardi, 1996). *Activity theory* therefore emphasises social factors and the interaction between people and their environments.

The HANABI project can be represented as an Activity System. The students are the *subjects*, the *object* of the system is to improve the students' language skills and the *community* is the body of academics across the network of universities. The learning materials are then co-developed with the institutional rules of course assessment, the division of responsibility between universities and, most obviously, the artefacts of the DSi and its standard software.

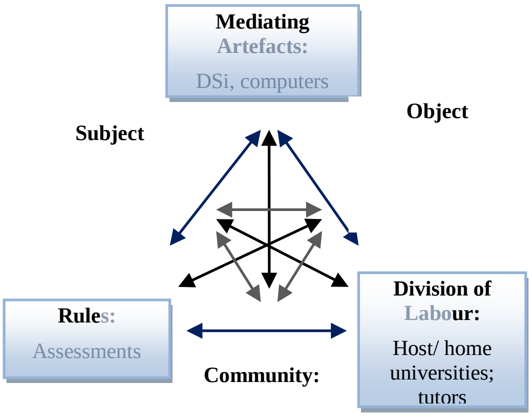

Figure 1: HANABI Project as an Activity System, based on Engeström's Diagram (Engeström, *et al*., 1999 [2003]: 31).

In developing HANABI we should expect to see that the use of the consoles/software, the institutional rules of assessment and the relationships between the UK university and their Japanese partners will all be shaped by the need to create an effective learning system linking the students to their need to improve their Japanese language skills.

3. BACKGROUND

Since its inception the MA Honours in Japanese programme at the University of Edinburgh has required students to spend their third year of study at a university in Japan. At the host institutions in Japan they follow a Japanese language course for overseas students at an appropriate level, and, depending on where they study, may also be offered Japanese Studies courses in English, auditing of some lectures in Japanese with the home students, or workshops and study days on Japanese culture. They are also encouraged to take part in intercultural activities with Japanese and other visiting students. Most of them live in university accommodation, sharing with Japanese and international students. Thus, students experience cultural immersion while they improve their language skills. However, some students have encountered issues with social isolation, limited pedagogical support from their home institution, and disparity in the learning outcomes/achievements after the completion of the programme due to the differences amongst host institutions' courses/curriculum. Furthermore, assessment of the third year programme is conducted retrospectively, which has led to a failure to address pedagogical support problems when they arise.

The HANABI project was initiated in November 2009 to assess whether language learning support using mobile devices can make a contribution to ameliorating these issues and to assess the potential of using mobile learning more generally for other languages and for other academic subjects. A range of mobile devices suitable for delivering m-learning content were considered, including netbooks and smart phones, but the Nintendo DSi was selected on the grounds of its cost and functionality . Nintendo DS series are the best-selling handheld system in the world. As of the end of December 2009, worldwide shipments of the Nintendo DS series reached 125.13 million units (see http://www.joystiq.com/2010/01/28/ds-sells-125-million-worldwide-wii-up-to-67-million). Japan is the home country of DS and the series have been widely used in Japan by a range of age groups for entertainment as well as educational purposes. The infrastructure for using the Nintendo DSi linked through WiFi in Japan is now developed to the point that a project of this type is viable. Twenty-five DSis were purchased in Japan and each student was provided last December with a DSi. Each student attended a 3-hour orientation session in either Tokyo or Osaka at which a Japanese language tutor explained the purposes of introducing the DSi as a supportive mechanism to enrich their exchange programme experience. There were two non-attendees out of the cohort of 23 students due to other commitments. However, these non-attendees were supported by the language instructor/tutor via email and visually rich manual wiki pages with their co-students giving practical support where possible. The project wiki site (cf. https://www.wiki.ed.ac.uk/display/JISC/JISC+Learning+and+Teaching+Innovation;jsessionid=1B9F5A028A990EE4E39C968DA686342C) includes online access to all the information, including how to use the DSi, how to respond to each task, a listing of available free hotspot areas in different regions and all the tasks sent to the students.

4. EDUCATIONAL INTERVENTION VIA DSi

There are a range of advantages to using a DSi to provide language support to the students on the exchange programme. First of all, it is a portable and relatively low-cost mobile device which has an 802.11b wireless adapter built-in, allowing the DSi to access the internet via any compatible wireless network (it is compatible with both WPA and WEP encryption for Internet applications such as the free of charge browser *Opera* while compatible with WEP encryption for DS games which utilize Nintendo WFC (Wi-Fi Connection)). A range of free DS software is also available, in particular *Flipnotes* which can easily be used for educational purposes. After the initial investment in purchasing the game consoles (approximately £120 per console at Amazon UK) there were no further costs for software of internet access. The DSi has a simple intuitive interface with easy operation, with voice/sound recording functions, a screen allowing users to draw freehand with a stylus pen in three colours, and a camera to take photographs for inserting in *Flipnotes* or posting to *Facebook*. In particular, Japan has WiFi hotspots/free connection points provided by Nintendo for DS users (see http://www.nintendo.co.jp/ds/ds_station/shop/index.html for a list in Japanese of free Nintendo WiFi stations) as well as cafes or fast-food shops offering WiFi connections

(http://www.freespot.com/users/map_e.html for a list in English of free hotspots). This potentially allows students to engage with the assignments from the home institutions in flexible environments.

Amongst all advantages, the most important aspect of using the Nintendo DSi for Japanese language learning is that users can handwrite directly onto its touch screen with the stylus provided with the console. Handwriting practice is very important for Japanese language learners as there are three kinds of script in Japanese: more than 3000 Chinese characters (*kanji*) and two sets of Japanese characters (*hiragana* and *katakana*). In principle, the graphics function allows the user to write any script, which is difficult or impossible with other portable devices such as mobile phones, thus giving the project the potential for expanding its findings to other languages with non-European character sets. (*Note:* OCR technology for Japanese, which matches the user's graphical (bitmap) input with an internal dictionary, is now stable; the viability of other languages would be dependent on OCR technology being available for the pertinent script.) *Ugoku Memocho* (Flip Note) software, which is provided free by Hatena, allows users to draw graphical representations of Japanese characters, record spoken sentences and share them with their fellow students and their tutors. Tutors have provided students with fortnightly language exercises for the first three months of the project. The students have posted their responses back to their tutors as well as the course web site and in return their tutors have provided feedback prior to the delivery of the following week's exercise. With the use of dedicated free web space, "Ugomemo-Hatena", the students' responses, both written and oral, are shared with other students online. The online tutors have provided both regular and spontaneous, context-dependent tasks and feedback to the students in Japan.

A series of exploratory task-oriented assignments have also been sent to the students to assess their hand-writing skills, check their pronunciation by recording their voices, test their vocabulary/kanji capabilities and evaluate their practical/creative composition capacities. Students who completed the tasks could send them directly to their tutors located in Edinburgh, but they are also encouraged to upload their work to the course web site which is a shared space with a peer-reviewing star system. Tutors can provide feedback directly to the students via DSi or by uploading their feedback to the course web site.

The students are expected to take an external Japanese language examination called the *Japanese Language Proficiency Test* on their return to Edinburgh. As part of the preparation for the examination, provisional online drilling tests targeted at two different levels were distributed. All the instructional materials were produced by language tutors in Edinburgh and distributed with deadlines for their completion. In parallel to these activities, Facebook is being used to create an online student community and potentially an alternative space to share and monitor their experiences abroad.

5. EVALUATION AND FINDINGS

The student participation was not as high as expected during the period between January and April 2010. In order to understand how the students perceived the use of DSi for language tutoring from the home institution and what kinds of elements have been preventing them from participation, an online survey using Bristol Online Survey tool was conducted in early April. Direct emails were sent out to each student while they were also contacted through Facebook's course group site as an alternative gateway. According to the student survey (15 replies out of 23; 65.2 % response rate), 9 students out of 15 respondents (60.0 %) had been participating in the tutorial activities using DSi while 6 students (40.0 %) clearly stated that they were currently not using the device. The study has identified the three categories of students on this project: 1) keen users (5 people), 2) moderate-low users (4 people) and 3) non-users (6 people).

Most keen users (5 students out of 15 respondents, 33.3%; one student used DSi daily, two use it 3-4 days and another two students use it at least once or twice weekly for Japanese language learning) already had their own DSi (2 students) /DS Lite (2 students), therefore they were already familiar with the Nintendo DS/DSi prior to the project. This group of people were making the most of this opportunity. The students in this category appeared to respond quickly to language tutorial activities once the tasks were given unless they had other priorities such as examinations. Their usage of the device extended beyond the language learning tutorial activities. For instance, they used DSi as an electronic dictionary, as a mobile device to access the Internet, to visit social networking sites and as a digital camera. They also used the device for gaming and hobbies by using additional DS software that they installed.

Four students (26.7%) were categorised as moderate-low users. Two students (13.3%) used DSi occasionally and another two students (13.3%) used it very rarely. In this case, occasionally or rarely means that they participated in some of the DSi tutorials but not all of them. It was the first time for three of them to use a DS and one student already had their own DSi. The first-time users in this group were making efforts to familiarise themselves with the DSi and trying to participate in the tutorial sessions. Compared with the keen users, the usage of DSi outside of the language tutorials was limited. Beyond language tutorials, only one student who had their own DSi was using it for gaming.

There were six non-users (40.0%) and all of them stated that they had not used it for Japanese language tutorial sessions or for any other purposes. It was the very first time for the five students to use a DSi while only one student stated that they had used a DS Lite prior to the project. This student commented that they wanted to participate in the tutorial activities but their environment did not allow them to access any WiFi environment unless paying for coffee or any menus to obtain free WiFi.

The survey shows that none of the respondents had found using the DSi very difficult and only one student, who is categorised into the group of medium-low users, answered that they found responding to the tasks provided by the tutors from the home institution too difficult. The top three factors which prevented the students from participating in the activities were (multiple-answered): 1) lack of time to use the DSi due to the heavy workload at Japanese university (4 students) and/or their busy social life (3 students); 2) difficulties in accessing/ connecting DSi for Japanese language learning (4 students) and 3) no interest in using a DSi (4 students). The following section draws upon *activity-theory* to consider these barriers to DSi use by looking more closely at student comments and developing practical insights into how participation in Japanese language tutorial exercises at distance may be increased and the students' mobile learning experiences improved.

6. EMERGING EVALUATION ISSUES OF INTEREST

Students who were already familiar with DS/ DS Lite/ DSi were making most use of the game consoles. Some students used the DSi as an alternative mobile device to access the Internet while others practise their Japanese with other DS educational software. One student has a Home-brew software application designed for the display of flashcards so that they can create their own databases using CSV files and practice kanji on the train. For such self-contained educational use network access is not required. However, in order to participate in the tutorial activities, a WiFi connection is essential. This section looks at issues for networked language learning via DSi to improve our current practices.

6.1 WiFi Connection

> *I think it is a good way for tutors to monitor our progress and keep us informed of their expectations for our Japanese progress but using Ugoku memo can be somewhat cumbersome at times and finding a wifi connection is not especially easy for me.* (First time user, female)

Some students see the advantage of using DSi for supplemental language tutorials from the home institution, as the above quote shows. That is, they can see the objects of the activities. However, accessing a WiFi connection seems to be a barrier for some of the students. We expected the availability of Wi-Fi connections for DS consoles to be most advanced in Japan and that the students would easily have access to on-campus WiFi connections or be able to find free Wi-Fi hot-spots based on the information provided by the tutors. In fact, the project has identified that it is still difficult for everyone to secure free WiFi access. Most host universities provide a WiFi network for their students, but the DSi requires certain security settings to access the institutionalised WiFi network. This has been easily resolved at the University of Edinburgh by collaborating with the university's Information Services engineers and it has eventually been possible to resolve this at the host institutions. However, this required permission and cooperation from each host institution. Some students have made efforts to bypass their institutional WiFi provision and access the internet at open public WiFi hotpots, but this is often only possible if a customer buys their products (e.g. coffee at a cafe).

> *I feel this could be a very useful means of learning whilst studying abroad, however my situation does not allow for easy use of this. I live with a host family and there is no way for me to connect my DSi to the internet and access the relevant files for doing the mini-assignments. My university does not have a wi-fi facility either to allow me to connect my DSi to the internet. I am also not within easy reach of a Free Wi-fi area like McDonalds, I would have to pay £5-£10 every time to go to an area where there is such a thing, which is extremely costly in Japan when you have no scholarships and given a bare minimum loan.* (First time user, male)

The securing of free WiFi spots without financially burdening the students is a top priority for the sustainability of this initiative. WiFi access is a fundamental element of the project as it is the basis for the sharing of information with tutors and co-students. However, the communities where the students are located do not provide ideal environments for WiFi access.

6.2 Enrolling the Students to the Activities

Access to WiFi is necessary for students to be able to use a DSi to access the learning materials and to complete the tasks, but once access is possible the student must actively choose to participate in the exercises. Enrolling the students to the language tutorial activities with DSi may not be as straightforward as it was originally envisaged. This is because students need to share the same objects and goals to be a part of the mobile language learning activity system. However, the positive perception of the mediating artefacts may not necessarily be shared by all the students. One of the students has left an interesting comment on his perception of DSi as a learning tool:

> *It is a child's gaming system and having to access it in academic buildings is embarrassing…. I am abjectly negative towards the DSi language tutorial sessions as I feel it is once again a very child-like interface.* (First time user, male)

Some students may have fixed views about common artefacts like game consoles. Another student mentioned that he uses an iPhone as his main mobile communicative device and the use of DSi as mobile communicative tool is not appealing to him. If the students can possess fixed views about certain artefacts this should be a consideration when selecting a mobile learning platform. The students seemed to be enjoying practicing *kanji* using a stylus pen onto the touch screen. However, some students also pointed out the difficulties or cumbersomeness in writing complicated kanji neatly or composing long sentences within the limited space. This can make the students self-conscious about their hand-writing and unwilling to upload their work onto the course website. However, this would be soluble if the tutors could devote sufficient time with the students until they have gained confidence in writing with the stylus pen on the DSi screen before they go to Japan.

Apart from the negative perceptions of the artefact, it is also important to consider the context in which the language tutorials are occurring.

> *[A]lthough using the DS is helpful and I can see how it is beneficial, because the host university I am studying at provides a fantastic but very intense course, I feel slightly pushed for time to do the tasks. In the Waseda programme, - which I am loving every minute of - a lot of work is demanded of us inside and out of classes. As a result, my Japanese is definitely improving day in day out, and due to that I am keen to continue focussing on my current host university course. Without wanting to sound negative about the DS course, I feel I should say that on top of my current studies, accessing wifi and doing the tasks relatively quickly from the time that they are issued so as to keep on top of them, can sometimes be a bit of a push.*

This mobile learning project is distinctive in the context in which language learning is occurring. The environments in which learning occurs significantly vary amongst the students. Students being away from the home institution are all working at the host institutions following institutionally tailored language curriculum. Some institutions have very rich and demanding language programmes in parallel to busy social and cultural life outside the campus. “One size fits all” assignments cause confrontation or resilient resistance/refusal from the students regarding the compulsory participation in the activities.

> *I am not very keen on the DS project as I feel that it distracts from giving us other Year Abroad assessment which would be more beneficial and could contribute towards our final degree classification. It is also quite a responsibility to be trusted with a very expensive piece of electronic equipment on a compulsory basis. However the concept as a whole is novel and exciting* (First time user, male)

Assessment is actually a powerful pedagogical drive for most students and can be used as rule in the activity system to regulate and normalise the activities. However, if this initiative is to become a compulsory course element, it may be worthwhile considering making this part of their assessment and this is something that programme director at the home institution to consider. Also, there is a division of labour in responsibility for teaching during the programme between the host institutions and the home institutions and blurring this boundary may cause conflicts between the two institutions.

6.3 Socio-cultural Issues: Different Academic Calendar

Cross-cultural e-learning initiatives can be affected by institutionalised socio-cultural differences. For example, Japanese and UK universities operate to different academic calendars. In particular, the different holiday periods (e.g. longer New Year holidays and Spring Holiday in Japan) and different examination periods amongst host universities have led to a lower than expected levels of participation in the activities. Once students have lost the momentum of using DSi after the three hour orientation session in Japan in December, it has become difficult to bring them back to the use of DSi unless they have already been familiar with DS/DSi or have a passion for using new technology. To address the problem of non-participating students, we shall be in more frequent contact with students and provide them with support based on the comments expressed in the survey so that we can improve the level of students' participation and keep them motivated. Further, in order to shift the load from the students, we will secure sufficient time for instruction in DSi use and provide a schedule of learning activities before the students go to Japan from the next academic year. The schedule includes all the information and the deadlines for the tasks so that the students can obtain an overall picture of the project and also to help them to manage their time efficiently.

CONCLUSION

This paper has shown that the use of DSi as a mobile learning platform has great potential if it is used in combination with shared web spaces, such as *Hatena*, and social media, like *Facebook*. However, it has been found that there are issues which need to be addressed in order to improve the students’ language tutorial experiences further. The successful implementation of such activities requires them being grounded in a contextualisation of activities, shared goals, positive views of the mediating artefact and operational environments, as Engeström’s diagram shows. The targeted activity, that is participation in the tutorial activities, is viewed in terms of how the tutors and students initiating the action conceive of its underlying purpose or goal. In this sense, clear demonstration of the pedagogical goals for the activities and framework to the students will be helpful to realise more inclusive and meaningful participation. In order to take actions to participate in the activities, they need to be well-informed of the purposes of the activities and pedagogical benefits as an incentive. For example, Merrill (2008: 271) emphasises the importance and effectiveness of instruction in any learning landscape to make the learning experiences effective, efficient and engaging. In particular, ‘open ended learning environments’, like the one this project is located in, require more sophisticated instructional design than with more direct instruction. Furthermore, in order to keep the operation feasible and sustainable, the fundamental easy availability of free WiFi access is essential. Also, socio-cultural differences between the UK and Japan, for example academic calendars, need to be taken into consideration when the cross-cultural activities are planned. The contexts in which the language tutorials sessions occur are complex in nature. The students are based in universities with diverse practices. It may be useful to consider the expected student workload at each host institution to identify the level and kinds of pedagogical intervention that will be useful without becoming too intrusive. Thus, developing exercises aimed at the entire cohort must be sensitive to this contingent heterogeneity. The pilot has demonstrated that mobile devices can be a useful means of keeping a dispersed body of students in touch with their tutors and with each other, providing valuable feedback on learning.

In this paper, the project was evaluated through the online survey which provided us with concurrent insights into students' perspectives. The students have now returned from Japan and we are conducting semi-structured in-depth interviews with the students to explore in more detail how their motivation, goals, environments, and mediating artefacts interacted in the processes of their participation in the tutoring activities.

By incorporating the lessons learnt during the project evaluation into the design of learning exercises, negotiation of network access and familiarisation of students with the devices, the use of the DSi will become embedded into the year abroad for future students. The insights gained will also be applied in exploring the possibility of using mobile learning in other language programmes and wider degree programmes with dispersed bodies of students.

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On the Design of a Flash-based Mobile Live Lecture Broadcasting System for Continuing Education

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Abstract

Being able to access the live course while on the go is a highly desired feature by many students taking continuing education. In this paper, we present the design of a mobile live lecture broadcasting system for this purpose. It enables end users to watch the video, audio and slides of a lecture happening in the remote classrooms right from their smart phones. Adobe Flash was chosen as the underlying cross-device multimedia streaming platform due to its wide client-side support on various smart phone OSs. As the Flash technology lacks of the live screen cast support, a novel adapter module based on the mirror-driver mechanism and the virtual camera conception was developed to fill this gap. A small scale pilot based on this system has been conducted at our college, which has proved the effectiveness of the design.

Key words

live lecture broadcasting; screen casting; Adobe flash

1. Introduction

Many students taking continuing education are mostly full-time employees. They are often too busy to come to the classroom regularly, so e-learning is more and more adopted in the field of continuing education. Among the various e-learning forms, taking live lecture is preferred by some students than viewing VOD(Video-On-Demand) afterwards. For one reason, they can have real-time interaction with the lecturer, as supported by many live lecture systems. Another reason is that they are somewhat "forced" to keep up with the pace of the course during the semester by taking live lectures regularly, while many students relying on VOD solely are likely to be found still being far behind the schedule around the end of the semester. However, sometimes they just couldn't seat in front of a desktop PC on time for the live lecture. For examples, they happened to work late and were still in their commute when the lecture started. So it is a big advantage for them to be able to join a live lecture even on the move, for example, on a bus or metro, rather than completely miss it. Therefore, we designed such a mobile live lecture broadcasting system for students of our college.

During our design, we took into account the following requirements:

1. Mobile users should be able to enjoy the live audio, video and screen of the teacher's presentation PC from their smart phones.
2. The system should support as many types of smart phone OSs (Operating Systems) as possible.
3. The system should provide a smooth user experience for mobile users to use this system. As installing 3rd party software on smart phones is still a somewhat demanding technique for ordinary users, it is highly preferred that the system can be deployed as a Software-as-A-Service model, where no explicit client program download and installation procedure are required.

After a careful study of all alternative technologies available, we found that Adobe Flash [1] could meet the above requirements well. Flash player is widely pre-installed on many smart phone OSs and it supports live audio and video streams. However, it lacks of direct support for screen casting. Therefore, adding support of screen casting on top of Adobe Flash technology is the focus of our development work of this system.

The paper is structured as follows. In section 2, we describe the rationale to choose Adobe Flash as the underlying technology in more detail. In section 3, we

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introduce the adapter module that enables screen casting on top of Adobe Flash. In section 4, we describe the architecture of the mobile live lecture broadcasting system deployed in real classrooms. In section 5, we present the result of the pilot conducted at our college. In section 6, we make comparison between our system and other related works. The article is concluded with a discussion of future work in section 7.

2. The Choosing of Adobe Flash as the Underlying Technology

Today's smart phone OS markets are very fragmented. There are many alternatives such as Android, iPhone, Symbian, Windows Mobile, Palm, etc. For our system to have real use, we have to support as a wide variety of mobile platforms as possible. However, it is not scalable to develop and maintain client programs in native code for each of these platforms respectively. To make it worse, even in the same platform there are many sub-platform variations which are not compatible with each other with respect to the application API. For example, applications developed for Symbian S60 v3.x cannot run on Symbian S60 V2.x, vice versa [2].

Therefore, instead of developing client programs in native code, we tried to leverage some cross-device middleware platforms, especially those with mobile devices support. After a careful survey, we found Adobe Flash meet our requirement well. Besides its prevalence in desktop environment, Flash Player is also widely pre-installed on many mobile platforms. Almost all Symbian based smart phones have a variation of Flash Player called Flash Lite pre-installed. Moreover, according to the roadmap of Adobe[3], the newest versions of most smart phone OSs will have pre-built Flash Player 10.1 in 2010(currently Apple iphones,ipods and ipads, do not support Flash).

Adopting Adobe Flash brings in the following benefits to our system. First, there's no need to do porting of the client program onto different platforms. Second, its built-in audio and video stream capturing, encoding and decoding capabilities can be readily used in our system with the help of some simple glue logic written in a high-level scripting language (ActionScript). So the development lifecycle is greatly shortened. Furthermore, as Flash players are deployed as pre-installed browser plug-in, the students only need to type the URL to their mobile browser and then they are ready to join the live lecture - no program is needed to be downloaded and installed explicitly.

3. Adapter Module for Screen Casting

Screen casting is widely used in live lecture to broadcast the presentations made by the teacher on his/her PC to remote students. However, as far as we know, Adobe does not provide a publicly available solution to do live screen casting with Flash technology.

Therefore, we created a novel adapter module to support live screen casting in our system. The module is based on the mirror-driver mechanism and the virtual camera conception. The adapter module is shown in Fig.1.

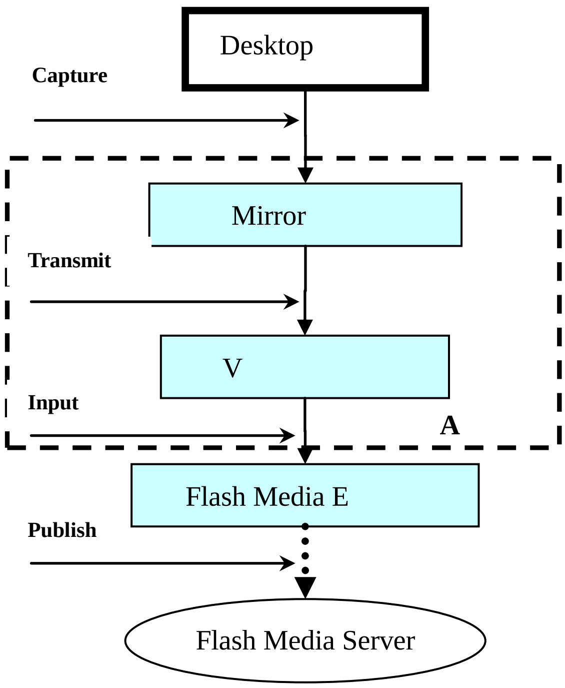

Figure 1: Adapter Module

The mirror-driver is a mechanism on Windows which can efficiently capture the screen image data [4]. Mirror-driver is a virtual display driver. It hooks kernel-layer APIs related to display behaviors so that it can easily tell the changed area on the screen. Compared to other alternative screen capture mechanisms, such as screenshots by graphical display APIs, application-layer

API hook, the mirror driver has the advantage of low computation cost and robustness in catching all screen update actions.

Flash Media Encoder is the standard video encoder component provided by Adobe to encode and publish live video and audio stream to Flash Media Server. However, it only supports camera or video capture card as the video stream input. So we implemented a virtual camera to bridge the mirror driver and Flash Media Encoder. The virtual camera simulates the interface of a standard camera which the Flash Media Encoder can open, and it then converts the screen stream received from the mirror driver into the standard video format. In order to improve efficiency, only the changed area on the screen is transmitted from the mirror driver to the virtual camera.

Flash Player on the smart phone is able to retrieve and decode live video stream. We wrote a simple script code at client-side to subscribe live video stream. There was no need to write additional specific code to support our adapter module at client-side.

4. System Architecture

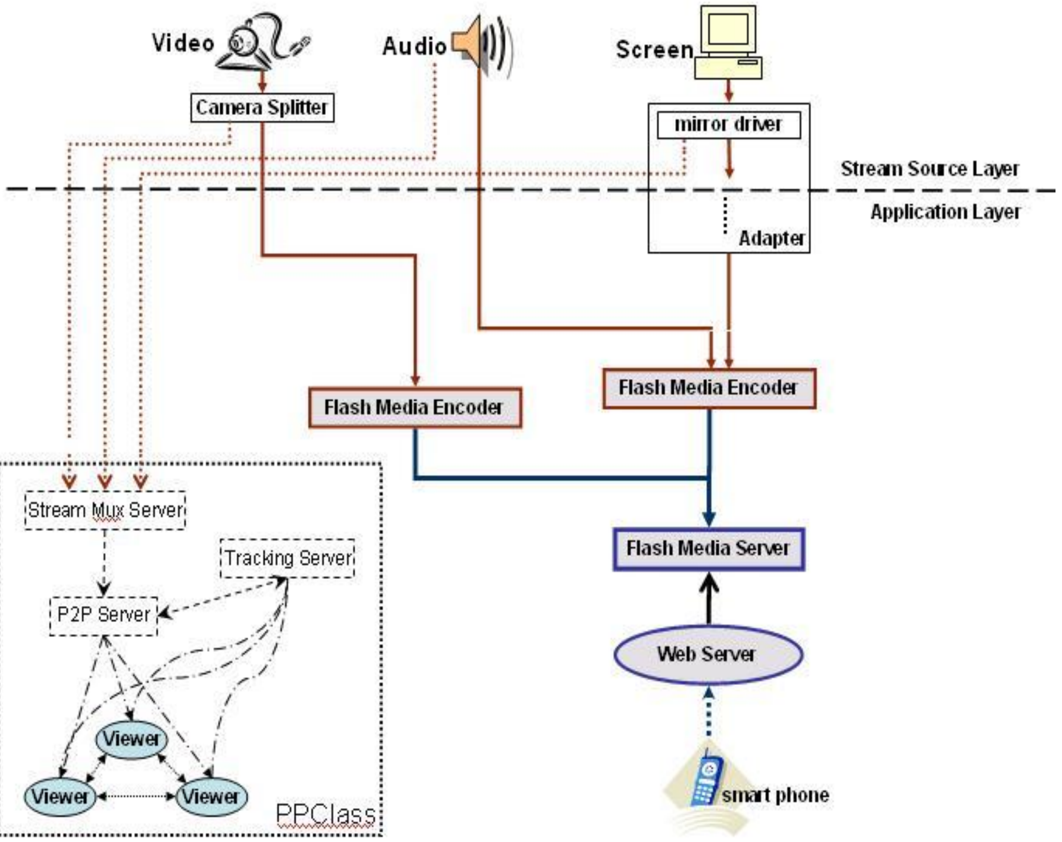

Figure 2: System Architecture

We had already deployed a live lecture broadcasting system at our college for desktop users in real classrooms, named PPClass[5]. In this paper, we present the system supplement to PPClass for mobile users. The two systems are required to run simultaneously on the same desktop. They all need to capture audio, video and screen stream. Therefore, we designed a two-layer structure, as is shown in Fig.2. The **Stream Source Layer** is in charge of capturing all 3 streams from devices and providing stream sources for different **Application Layer** systems. To implement it, video stream and screen stream are preprocessed as follows:

1. Video stream is captured from a camera. It could not be shared by multiple processes on the same desktop directly. We place a Camera Splitter[6] before the camera. It can capture video stream from the camera and distributes it to multiple processes.

2. Screen stream is captured by mirror driver. We designed our own data-splitter for mirror driver. It can

distribute screen stream from mirror driver to multiple processes.

Audio stream can be shared directly on Windows XP or later version of Windows Thus it needn't be preprocessed.

In **Application Layer**, there are 2 different systems sharing the same 3 stream sources. The mobile live broadcasting system consists of an Adapter module, two Flash Media Encoders, a Flash Media Server and a Web Server.

The Adapter module is as described in section 3. The video stream is captured by one Flash Media Encoder, while the audio and screen stream are captured by another. Both Flash Media Encoders publish streams to the Flash Media Server. The Web Server hosts a Flash Media Server application that receives live streams from Flash Media Encoders. It then sends those streams to smart phones.

Moreover, in PPClass, students could have real-time interaction with the lecturer by typing in the browser or sending short messages. In mobile live broadcasting system, short message interaction is also supported when a lecture is in progress.

5. Pilot

A small scale pilot based on the live lecture broadcasting system for mobile users has been conducted at our college in a real classroom. We deploy **Stream Source Layer**, Flash Media Encoder and PPClass encoder on a single PC. The Flash Media Server and Web Server are deployed on another remote desktop.

The codec, quality and bit rate of 3 streams are shown in Table.1. A snap shot on smart phone is shown in Fig.3.

Table 1. stream parameters

Stream	**Codec**	**Quality**	**Bit Rate**
Video	VP6	176×144, 10fps	30kbps
audio	MP3	11kHz	18kbps
screen	VP6	320×240, 2fps	100kbps

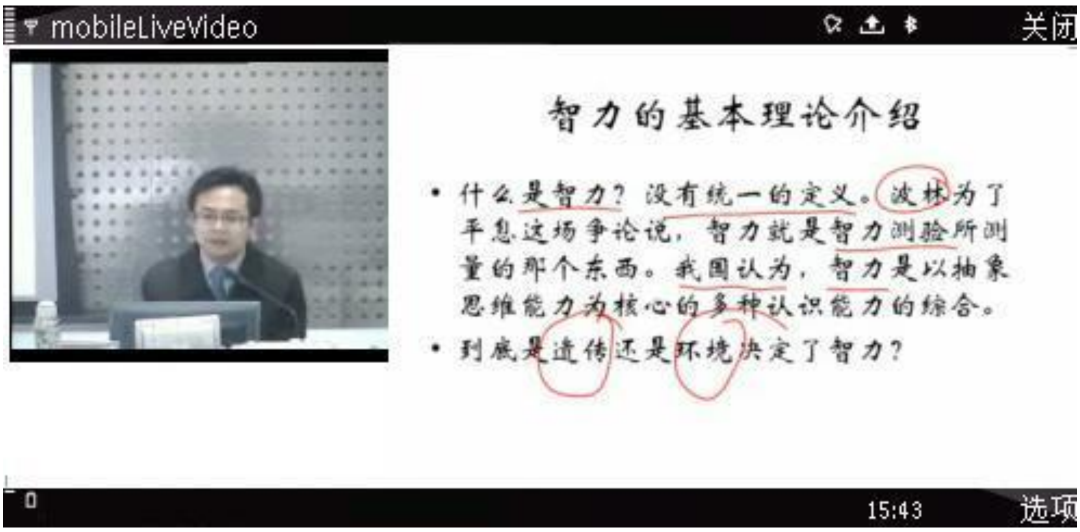

Figure 3: Snap shot on smart phone

Regarding the efficiency, we monitored the CPU utilization of the PC in the classroom. Table 2 shows the hardware configuration of the PC and CPU utilization of each process. The result shows that the two live broadcasting systems are running well under a manageable CPU utilization.

Table 2. Hardware configuration and CPU utilization

Hardware Configuration	**CPU**	**Intel Pentium(R) D CPU 2.80GHz**
	Memory	**2GB**
Process	**Description**	**CPU utilization(avg.)**
Flash Media Encoder	For video stream publish	4%
Flash Media Encoder	For screen and audio stream publish	8%
Adapter	as described in section 3	10%
PPClass Encoder	encoder of our live lecture broadcasting system for desktop users	about 2%

6. Comparison with Related Works

We've investigated some related works. They all have their unique features but we found they are not suitable for us due to lacking of one specific function or another. Nevertheless, we've adopted some ideas from them.

Procaster[7] and Dimdim[8] are flash-based live broadcasting system. Their users are not required to download and install anything except flash player. The lecturer can also share computer screen to all attendees. However, they do not support smart phones.

Another kind of system can broadcast from mobile phones, for example, Mobile Phones as Live Broadcasting Devices[9]. It can broadcast to mobile users from another mobile user with video, audio and screen stream. However, it does not support screen casting from desktop.

Camtasia Studio[10] had a previous version that could turn the screen recorder into a virtual video camera. We adopted this idea and designed our Adapter module. But we placed a mirror-driver and a data-splitter in Adapter instead of screen recorder that Camtasia Studio provided. Compared to Camtasia Studio, our system could support multiple processes retrieving data from the mirror driver simultaneously.

7. Conclusion and Future Work

The current system is useable but is still preliminary in many aspects. Two specific enhancements we plan to make are as below.

1. As is well known, the actual available bandwidth of mobile network varies dynamically on many factors such as the type of the mobile network, the crowdedness of the cell, etc. An ideal mobile live lecture broadcasting should be able to adapt its content to the dynamic available bandwidth to maintain the best possible user experience. One simple adaption policy is sending out a subset of all the 3 streams when the available bandwidth cannot afford the full streams. For instance, if in limited bandwidth scenario of about 50kbps, the mobile phone will subscribe audio and video stream and neglect screen stream.

2. Generally, the screen of a mobile terminal is not large enough to display PC screen at its original resolution. Simple downscale is applied to the pilot now, which may results in low-quality literals. We'll use better downscale algorithm in the future.

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nQuire: A Customizable Toolkit for Inquiry Learning across School, Home and Field Trip Locations

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Abstract

Personal inquiry learning involves students in carrying out investigations in personally relevant contexts. Over the past two years we have been developing nQuire, a toolkit to support this pedagogical approach. nQuire allows students to continue learning across locations (school, home and field trips) in formal and less formal contexts. When planning and conducting inquiries, students need support with both regulatory processes (e.g. deciding what to do next) and transformational processes (e.g. formulating a hypothesis**)** (de Jong and van Joolingen 1998). This is particularly important in personal inquiry learning where inquiries span contexts, such as the home and school, that often may not provide immediate teacher support. As the inquiries should be personal, the ways in which the scripts are specified and customized has to be accessible to teachers and students. nQuire provides a forms-based approach to authoring and customizing inquiries. The evolving nQuire software has been tested with netbooks in a number of inquiries with students aged 12-15. This has included an after-school club in which students designed their own inquiries which were largely conducted off school premises in their own time.

Keywords

Inquiry learning, learning across contexts, independent learning, mobile learning, collaboration.

1. INTRODUCTION

This work is being conducted within the Personal Inquiry (PI) project supported by the UK EPSRC and ESRC Research Councils. The aim of the PI project is to support learning by engaging students in scientific inquiries that are personally meaningful and relevant to them. For example this has involved learning about the weather and climate by students studying climatic variations across their own town (Collins et al 2008) and learning about diet from records of their own food intake (Anastopoulou et al 2008). Students are supported in conducting the inquiry by a software script that can run on a mobile or desktop computer. nQuire, a software system or toolkit developed in the project, uses the scripts to generate the interface, tools and navigation of the inquiry (Mulholland et al 2009). nQuire supports the students in choosing and sequencing their forthcoming inquiry activities, carrying out current activities and reviewing their progress so far while working independently across school, home and field trip locations.

Making the authorship and/or configuration of inquiry learning scripts accessible to a non-technical audience was vital for two reasons. First, an important tenet of the project is that the inquiries conducted are not canonical, standard experiments but relate to the particularities of a learning context. The only way this can be achieved is for designs to be produced by or in participation with subject matter experts, such as teachers and educationalists, rather than designed for them by an external research project team. Also, as Murray et al (2004) point out, involving subject matter experts in design not only improves the utility of what is designed but also the usability of the authoring tools with which the design is created.

Second, facilitating the personal relevance of an inquiry requires not only teacher participation in the design but also a sufficient degree of learner control over the objective of the inquiry and how it is undertaken. We therefore not only require an approach to authoring that is accessible to subject matter experts, and also that the resulting inquiries present the students with a sufficient array of opportunities that are handled correctly by the software.

Providing this level of authoring and customization functionality presents a particular challenge in an inquiry learning context. Learners have well reported difficulties with both regulatory processes (e.g. deciding what to do next) and transformative processes (e.g. formulating a hypothesis) (de Jong and van Joolingen 1998). The scripts therefore need to explicitly represent both data transformation during inquiry and the structure and status of its activities. Visual formalisms and formal representations exist for specifying learning flow (i.e. the structure and status of learning activity), though these may not be completely appropriate for our inquiry learning context and intended designers. However, data transformation presents a potentially larger problem, where data such as the hypothesis articulated by the learner and measurements taken in experimental contexts play a role in multiple parts of the inquiry. For example, decisions on experimental method and what to measure will have an impact upon the content of a data collection form to be completed by the student. Difficulties of data flow specification within learning design have been documented (Dalziel 2006). To make data flow authorable and customizable by a non-technical audience, an approach to addressing this in the context of personal inquiry is required.

The next section of this paper reviews selected work related to learning design, the specification of data flow and inquiry learning. Section three presents a description of how the regulatory processes are defined and supported in nQuire. Section four describes the approach taken to providing support for transformational processes. In section five we outline the software architecture. In section six we describe how this has been used in project trials.

2. RELATED WORK

Inquiry learning involves students designing and carrying out investigations in order to acquire knowledge about the domain under investigation (White and Frederiksen 1998). de Jong and van Joolingen distinguish between transformative processes and regulatory processes. Transformative processes are defined as those that yield knowledge during the inquiry such as hypothesis generation, experimental design and data interpretation. Regulatory processes are those needed to manage the inquiry such as planning, progress monitoring and goal setting.

Scripts (Dillenbourg 2002) have emerged as an approach to guiding collaborative learning activities. Scripts provide a way of describing the activity in terms, for example, learner roles and tasks. Our aim is to apply scripting support to inquiry learning activities. Aspects of a script that support regulatory processes constitute the control flow. Aspects that guide the transformative processes correspond to the data flow of the script.

In recent years a number of researchers have highlighted the difficulties and problems in the specification of data flow within learning design formalisms and the support for data flow operations during their run-time use. With respect to IMS Learning Design, Dalziel (2006) has commented on the lack of functionality for data flow management and specification. Palomino-Ramirez et al (2007) point out that the user rather than the system, effectively becomes the agent of data flow, selecting data files specified in the activity description and incorporating them manually into the current activity. This places an additional overhead on the user and is prone to error (e.g. selection of the wrong data sources) which cannot be automatically detected and prevented. Palomino-Ramirez et al. (2008) propose an additional representation of data flow and a means of mapping this to the learning flow. Further research would be required in order to determine the prior training and usability of such an approach and therefore its accessibility to curriculum designers and teachers. Similarly, data flow specification and handling presents ongoing work for other learning design tools and representations (Dalziel 2006, Conole and Weller 2007).

Although the two contexts are not the same there are strong parallels between the challenges of data flow in learning design and research from the psychology of computer programming. Pennington (1987) in a study of computer program comprehension found that two largely distinct conceptualization of the program are constructed. First, the structure and control flow of the program has to be conceptualized, only then can a model of data flow be built. Building on this work, Corritore and Wiedenbeck (1991) conducted a study with college students in the second semester of a computer programming course. Though considered novices, most had some prior experience of computer programming and were computer science majors. On a program comprehension task it was found that their understanding tended to focus on structure and control flow and only the most able could conceptualize the data flow and intended real world function of the program.

These studies were conducted on procedural programming languages that emphasized control flow and in which data flow was more difficult to derive. More recently, within the field of programming language design, the object-oriented paradigm has tended to predominate. With object-oriented languages programs are built using “objects” that emphasize data structures and how they can be manipulated rather than the control flow of the program. However, object-oriented programming is often difficult for the programming novice and many languages aimed at or favoured by inexperienced programmers are often not object-oriented.

This work highlights some the difficulties in finding a way of specifying data flow as well as learning flow that is accessible to teachers and curriculum designers.

3. GUIDING REGULATORY PROCESSES IN PERSONAL INQUIRY

nQuire uses a number of constructs to guide regulatory processes. These are illustrated in the interface snapshot in figure 1 and described in more detail below. The inquiry shown in this paper, its structure, teacher instructions and student-entered text are drawn from a real example of a school microclimate inquiry carried out within the PI project.

Within the microclimates inquiry, the students hypothesized which of a set of locations would be best for a particular installation (such as a garden or picnic bench). They then selected scientific readings to take at each of the locations that could be used to inform their hypothesis (e.g. light level, windspeed). The students then took the readings at each location to obtain evidence that could be used in evaluating their hypothesis.

The inquiry is divided functionally into phases such as “Find my topic” and “Decide by question or hypothesis”. Phases represent the conceptual stages of the inquiry that the student should cover. Each phase can contain a number of activities. For example, in figure 1 the phase “Decide my question or hypothesis” contains the activities “My hypothesis” and “My key questions”. At any time an activity has one of four status settings to indicate whether the student can start, edit or view the activity, or whether the activity is unavailable. The four status settings and their icons are shown in table 1.

An inquiry can be divided temporally into stages. A stage could represent a short event within the inquiry process, a lesson or a longer period covering days or weeks. The stages of an inquiry are shown below the inquiry title, with the current stage shown in bold (figure 1). A stage can be associated with any number of phases, indicating that the student should focus on these phases and their constituent activities during this stage of the inquiry. Phases associated with the current temporal stage are suffixed by a star in the navigation panel. In figure 1, the first stage is the current stage (indicated by "1" being in bold) and the first three phases are labeled with a star to show they are associated with the current stage.

The teacher can change the stage of an inquiry using an additional option provided in their nQuire interface (figure 2). The teacher can specify the new stage using the drop down menu and also state which other stages should be available. This allows the teacher to specify the current stage but also have other stages currently available for students catching up or moving ahead.

If a stage is current or available then by default the activities of its associated phases (i.e. the ones suffixed by a star) are available to the learners. Operationally, this means that activities that have not yet been started can be started and those that have been started can be edited. By default, activities in phases not associated with the current stage can be viewed (if previously started) or are unavailable. The default settings for how a stage change effects access to a activity can be overwritten for specific activities or types of activity within an inquiry.

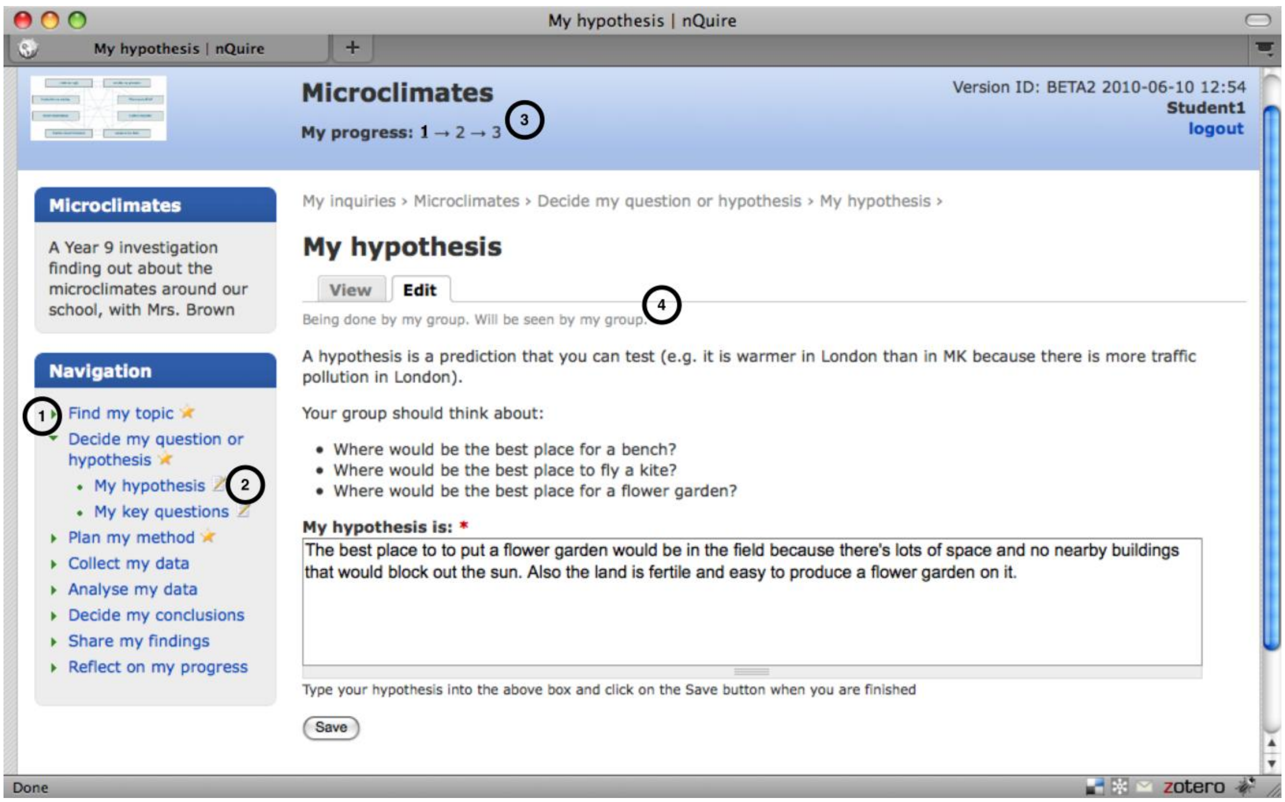

Figure 1. nQuire interface showing: (1) phases; (2) activities and their status; (3) stages; (4) performer and viewer of an activity.

Table 1. The types of status for an activity.

Status label	Interface icon	Meaning
Unavailable		Not available yet
Start		You can start this activity
Edit		You can edit this activity
View		You can view this activity

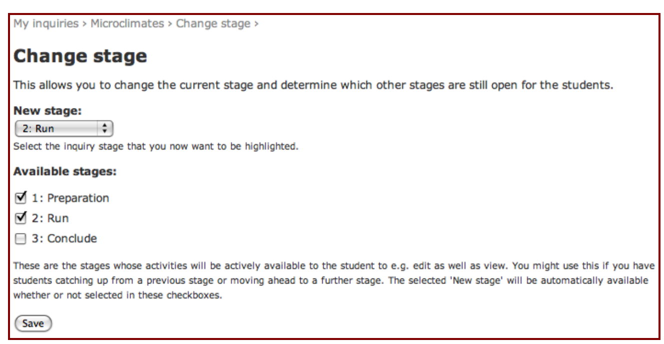

Figure 2. Setting the current and available stages of the inquiry.

For each activity, the teacher or inquiry author can specify who can perform the activity and who will be able to view the result. Each of these can be on the level of the individual, group or class. The activity shown in figure 1 involves writing a hypothesis. This is being carried out as a group activity and the hypothesis they create will be viewed by the group. For some activities, those able to view the result may go beyond the group or individual student who carried it out. For example, an activity may require an individual or group to produce a presentation related to their inquiry that is then viewable by the whole class.

The stages, phases and activities of an inquiry, as well as the inquiry itself, are authored using a forms-based interface. Figure 3 shows the initial form for creating a new phase for an existing inquiry. Authoring an activity requires the most detail as the author needs to state who will perform and view the inquiry, its initial status and the software module that will be used to generate that activity. Software modules are provided for generic activities such as answering a question, voting, and uploading and managing media such as images. Software for activities specifically related to inquiry such as designing the experiment and collecting data are described in the next section.

Further forms in the authoring process are used to view and reorganise the overall inquiry structure. Figure 4 shows a section of the visualization for organizing stages (shown horizontally), their associated phases, and the activities each phase contains. From here, the author can reorganize the inquiry structure or click through to edit the related activities.

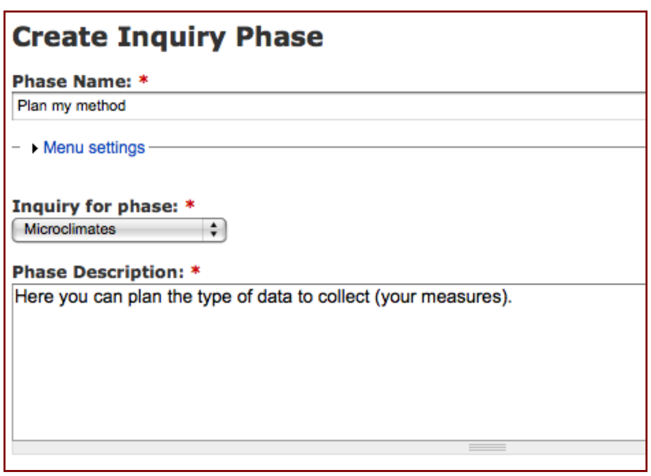

Figure 3. Specifying a new phase for an inquiry

In this section we have described the support for regulatory processes provided by nQuire and how they can be authored. In the following section we will move on to describe how transformative processes are supported and specified.

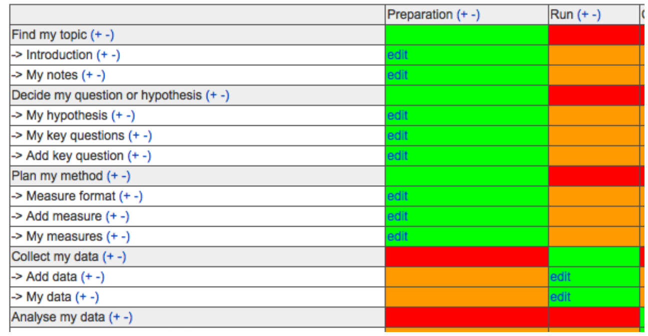

Figure 4. Organising the stages, phases and activities of an inquiry

4. GUIDING TRANSFORMATIONAL PROCESSES IN PERSONAL INQUIRY

The transformational processes of nQuire are supported by a set of available software modules for particular activities which the author can select and use within their inquiry structure. The software modules all read and write to a shared data structure to ensure that data added or decisions made in one activity correctly propagate to other conceptually related activities. For example, this ensures that activities used to design the inquiry appropriately effect activities in which data is collected and results analyzed.

The shared data structure is shown in figure 5. The *hypothesis* identifies the overall aim of the inquiry that is addressed in the final conclusion. An example hypothesis activity was shown in figure 1. The *key questions* break down the hypothesis into more operational questions that are nearer to the measures to be used in the investigation. These are used to organize and present the results, and are answered towards the end of the inquiry. An example key question activity is shown in 6. The learner’s hypothesis is shown above the key questions as a reminder.

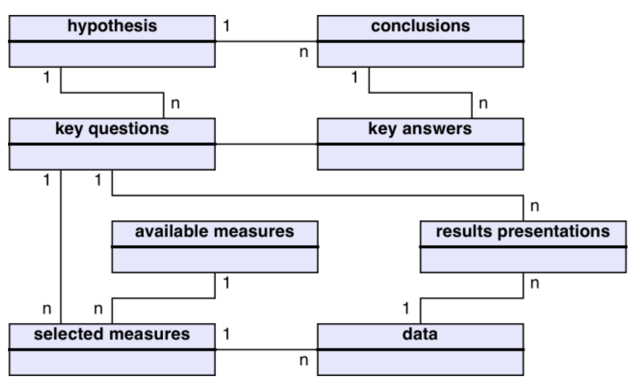

Figure 5. Data diagram illustrating the type of data structures needed to support the transformative processes of inquiry.

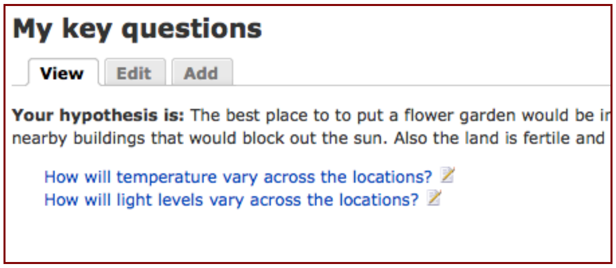

Figure 6. An activity for viewing and changing a learner's key questions for the inquiry.

The *available measures* identify the set of things that can be measured. These could be sensor readings, interview questions, image upload, audio recordings, et cetera. Each measure has a data type (e.g. number, text) and a mode of presentation (e.g. single or multi- line text box, pull down menu, file upload dialogue). A set of *selected measures* identify the available measures chosen for a particular inquiry (see figure 7). Some of the selected measures can be flagged as key measures which are used to organize the data. These can be thought of as similar to independent variables as operationally they are used to structure data collection and presentation, although the assumption regarding independent variables that they are controlled by the experimenter do not necessarily need to hold. For example, the inquiry could take the form of a correlation study in which no variables are manipulated by the experimenter.

In the example in figure 7 location has been identified as the key measure for the microclimates inquiry. A set of possible locations have been specified in advance for the students to choose from. Temperature, light level and notes are selected measures to be recorded in each data collection activity. Other available measures (e.g. humidity, image and windspeed) are not being used in the inquiry.

Each selected measure has a weight (i.e. ordering) used when listing and displaying data, and can be displayed together, within a data collection form or results presentation. The ordering of measures can be changed by dragging the cross to the left of each measure.

Each set of *data* readings contains the values for the corresponding set of selected measures. A set of data readings would generally be associated with a particular data collection activity and (possibly unique) combination of key measures. For a particular measure, multiple readings may be recorded (e.g. multiple temperature readings) from which an average reading may be calculated. In the example data collection activity shown in figure 8 the measures and their order reflects the choice made in the selected measures activity shown in figure 7.

A *results presentation* contains a set of data associated with some or all of the selected measures. Each presentation is associated with a key question that the data could help to answer. The ways in which the data presentation could be shown to the user are determined by the data types of the included measures. For example, numerical data can shown on a chart but textual data such as notes is just presented in a table.

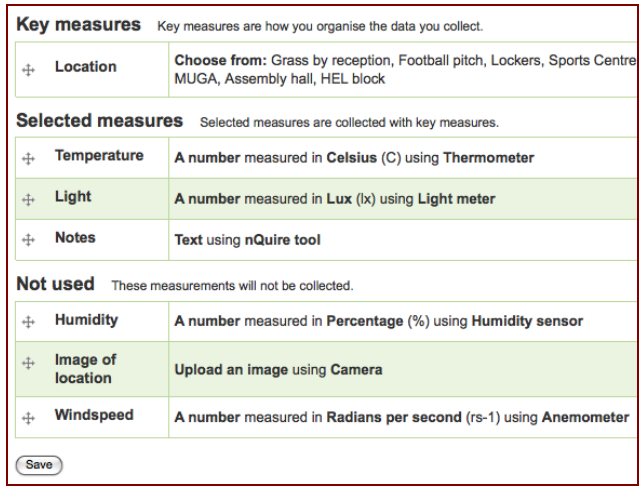

Figure 7. Selecting measures for use in the inquiry.

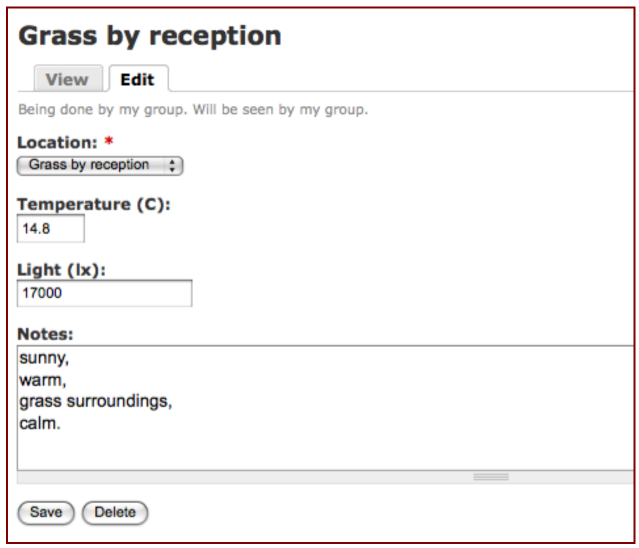

Figure 8. A data entry activity.

In figure 9 the learner has selected to compare temperature readings across locations and is able to view a generated graph. If geographical information is specified (in e.g. latitude and longitude) a map presentation can be produced in kml format that can be viewed in Google Maps or Google Earth and a "Download (kml) data file" link is shown at the bottom of the page. Location information can be associated with locations in two ways. First, latitude and longitude can be specified as selected measures and entered at each location using a GPS device. Second, if a pre-specified set of locations is being used, location data can be assoicated with each of them. Within the microclimates inquiry location information was specified in advance. For other inquiries that involved collecting climate data around a town, location data was entered by the students (Collins et al 2008).

The data included in the kml file reflects the measures selected by the student to appear in the results presentation. Figure 10 shows a Google Earth representation of the kml file generated for the temperature chart. The temperature data is associated with each location. If light levels or notes had also been selected then these would also have been included in the kml file.

A *conclusion* gives a response to, and is associated with, a hypothesis. A *key answer* gives a response to one of key questions and contributes to the hypothesis. Figure 11 shows answers associated with each of the specified key questions.

Other parts of the data structure are not shown for reasons of clarity. These relate to, for example, ways of customizing the specification of new data for particular inquiries (e.g. if the inquiry is based around a questionnaire then options related to scientific measures can be hidden).

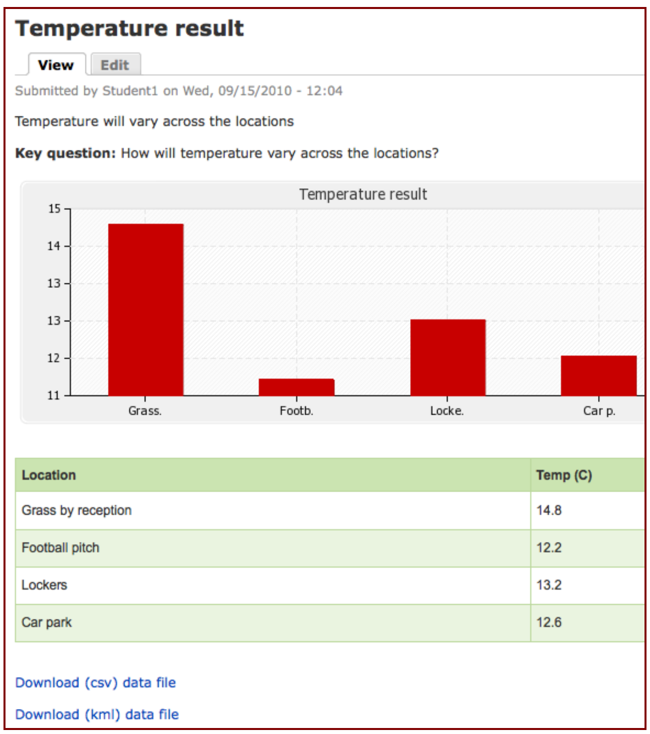

Figure 9. A graph presentation produced from the data.

The above data structure was abstracted from a survey of relevant school inquiries, including the ones we have supported ourselves. This represents the core data transformations performed in inquiries in which a hypothesis is proposed and where appropriate broken down into key questions. Measures are defined and selected into an experimental design intended to address these. Data are collected according to this design. Aspects of the data are represented to address the questions and hypotheses. This data structure can be used to represent a broad range of inquiries from questionnaires and surveys to controlled experiments. A full range of measures appropriate to the experimental design and domain under scrutiny can be defined and used to collect a range of data including location information, numerical data, free text descriptions and media objects including video and audio.

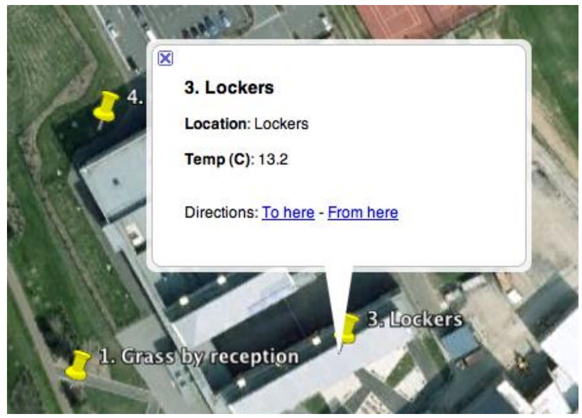

Figure 10. Viewing the kml file in Google Earth.

Figure 11. Answering the key questions.

The approach taken to authoring support for transformational processes in nQuire has deliberately taken a plug-in approach, where activities selected for use in the same inquiry share data in an expected way, according to the function of each activity within the inquiry, without this having to be specified by the author. This means that a new inquiry can be authored without the need to specify complex data flow. The built-in dependencies between the activities also allow for a great deal of customization during the running of an inquiry. For example, defining new measures and selecting them for the inquiry generates a custom structure for data analysis and presentation. A broad range of inquiries can therefore be developed by taking an existing inquiry structure, adding additional measures and then selecting and ordering them for use in the inquiry.

5. SOFTWARE ARCHITECTURE

The nQuire software was developed as a web-based application using the Drupal open source content management platform. nQuire makes use of in-built functionality provided by the Drupal platform and in addition provides a range of plug-in software modules. A set of "core" modules, required for any inquiry, provide functionality for authoring, conducting and monitoring inquiries. A further set of modules support specific inquiry activities such as collecting data and presenting results. In various trails, the software has been used in two ways. First, nQuire has been used from a central server with mobile or desktop computers as web clients. This has been the preferred option where reliable network connectivity can be established. Second, nQuire has been used as a stand-alone installation on netbooks comprising a web server, PHP, database, Drupal and nQuire specific software modules. This set up has been used on fieldwork activities without a network connection. A synchronization software module is then used to upload work to a central server after the fieldwork exercise.

Further details on the software architecture can be found elsewhere (Collins et al 2008, Mulholland et al 2009). An explanation of the various approaches used to network connectivity with the nQuire software and their strengths and weaknesses can be found in Gaved et al (2010). An online demo and software download of nQuire is available from www.nquire.org.uk.

6. USING NQUIRE TO SUPPORT PERSONAL INQUIRY LEARNING

During the project we have used the developing toolkit to support a range of inquiries within the science and geography disciplines. In terms of their authorship and customization, three main approaches have been used.

First, the toolkit has been used to author inquiries quickly in participation with the teacher. Here, the structure of the inquiry was specified in terms of stages, phases and activities. The activities concerned with experimental design (i.e. the defining and selection of measures) were then used by the teacher to pre-specify the design on behalf of the class. The inquiry was then conducted by the class. In this context, the software is being used by the teacher to define or customize an inquiry for the whole class. This approach was used in the climate inquiry that involved data collection by students walking across the centres of two towns. The structure of the inquiry and the experimental design were pre-authored in participation with the teachers. The prepared structure was then used to guide the students through data collection and analysis. For data collection in the field the software was installed on netbooks and then synchronized later with a central server. In the analysis stage, students accessed the central server from the school ICT suite and also at home with the netbooks.

Second, the toolkit has been used to author the inquiry structure and pre-specify available measures and hypotheses from which the students can select. Choices made and key questions added by the student are used to structure their activities concerned with data collection, presentation and concluding their inquiry. In this context, the toolkit is being used to scope the inquiry and provide options for the student which scaffold their later activities. This approach was used for the climate inquiry around the school grounds (from which the example in this paper is drawn) in which students made choices in the classroom, used the software on netbooks to guide their data collection while walking around the school grounds and then undertook results analysis back in the classroom using both the school ICT suite and netbooks.

Third, as part of our most recent trial we ran a more open-ended inquiry in which the students could pick their own topic, design their own experiment, and collect and interpret the data. This was carried out as part of an after-school geography club around the topic of sustainability. Here, the toolkit assisted the students in formulating their own inquiry design and modified the structure of the inquiry in response to their decisions. In this scenario, much of the inquiry design was done in the after-school club with assistance and input from teachers. All of the data collection was carried out independently outside of school by the students, supported by the software and netbooks. For example, one inquiry involved finding out whether fruit lasted longer depending on whether it was organic or "value" and whether it was contained in packaging. Students collected the data in their own homes over a nine day period using netbooks.

This illustrates ways in which the software provides an approach to the authoring and customization of inquiries that is accessible to teachers and students, and that provides explicit guidance for both regulatory and transformative processes.

7. CONCLUSIONS

Personal inquiry offers a personally relevant approach to inquiry learning. Scripted support for personal inquiries has to explicitly support regulatory processes and transformational processes as these are both challenging to the learner. This is particularly the case when inquiries span contexts such as the home that do not provide teacher support.

Given the personal nature of the inquiries, these structures need to be customizable or authorable by the teacher and students. We developed a solution that specifies support for regulatory processes in terms of stages, activities and phases, and individual, group and class collaboration levels. To specify support for transformational processes we use a generic data model based on inquiry learning and associated set of activities. These activities share data in predictable ways in order to propagate decisions made by students and teachers throughout the inquiry without the need for any complex data flow authoring.

The toolkit has a potentially broad use, particularly for inquiries that span more informal settings such as the home and involve students working more independently.

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An mlearning Journey: Mobile Web 2.0 Critical Success Factors.

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Abstract

This paper discusses six critical success factors for mobile web 2.0 implementation identified throughout fifteen mlearning action research projects carried out and evaluated between 2006 and 2009. The paper briefly outlines the implications of each of the five learning contexts involved in the projects in light of these critical success factors. The resultant development of strategies for future mlearning projects in 2010 and beyond are also briefly discussed.

Keywords

Mlearning, Web 2.0, Social Constructivism.

1. INTRODUCTION

Fifteen mlearning projects (Cochrane, 2009b; Cochrane & Bateman, 2010a) from 2006 to 2009 informed the identification of critical pedagogical success factors for implementing mobile web 2.0 within tertiary education, and were used to inform the planning of twelve subsequent mlearning projects in 2010.

1.1 Pedagogical Context

The mlearning projects encompassed five different tertiary courses, forming five core case studies spanning from one to three years of implementation and refinement, and involved a total of 280 participants. The learning contexts included: Bachelor of Product Design (2006 using Palm Lifedrive, 2008 using Nokia N80, N95, 2009 using Nokia XM5800, N95, N97), Diploma of Landscape Design (2006 Using Palm TX, 2007 using Nokia N80, 2008 using Sonyericsson P1i, 2009 using Dell mini9 netbook), Diploma of Contemporary Music (2008, 2009 using iPod Touch, iPhone 3G), Bachelor of Architecture (2009, using Nokia XM5800 and Dell Mini9 netbook), and the Bachelor of Performing and Screen Arts (2009 using Dell Mini9 netbook and Nokia XM5800). The research used a participatory action research methodology, and based its pedagogical decisions upon the foundation of social constructivist learning theories, with a focus upon facilitating student-generated content and student-generated learning contexts. See Cochrane and Bateman (2010a), and Cochrane (2009b) for summaries of the research methodology and project outlines.

1.2 Mobile Web 2.0

An explicit social constructivist pedagogy underpins each of the mlearning projects, forming the basis for the selection of tools to support this pedagogical approach. Mobile web 2.0 tools are web 2.0 services that are formatted for use with mobile devices including: blogs, Google mobile tools, YouTube, Flickr, Twitter, QR Codes etc… (Cochrane & Bateman, 2010b). These web 2.0 (O'Reilly, 2005), or 'social software' tools (Alexander, 2006; Mejias, 2006), share many synergies with social constructivist learning pedagogies. Web 2.0 supports collaborative group work, peer critique, formative feedback, user generated content, user tagging (categorizing and collating), and other processes similar to those used in social constructivist learning environments where the focus is on what the students do and discover.

> The application of social software in this manner supports a constructivist pedagogy where students feel empowered to take charge of their own learning (Mejias, 2006, p. 5).

Increasingly educators are harnessing web 2.0 tools for creating engaging student-centred learning environments. This appropriation of web 2.0 tools within a social constructivist pedagogy has been termed "pedagogy 2.0" (McLoughlin & Lee, 2008). This research was interested in appropriating the benefits of web 2.0 and pedagogy 2.0 anywhere anytime using mobile web 2.0 and wireless mobile devices (or WMDs), in particular WiFi (wireless ethernet) and 3G (third generation mobile 'broadband') enabled smartphones, and 3G enabled netbooks.

1.3 Identified Critical Success Factors

Based on the experiences gathered from the fifteen mobile learning projects between 2006 and 2009 the researcher has identified several pedagogical critical success factors as emergent themes for mobile web 2.0 integration (Cochrane, 2010a). These success factors were identified across the mobile web 2.0 projects by evaluating the following:

- The level of student engagement and satisfaction achieved – as evidenced in evaluative surveys and focus group feedback.
- The level of moblogging (mobile blogging) achieved by students in the courses.
- Lecturer reflective feedback.

The case studies identified the following critical success factors:

- The level of pedagogical integration of the technology into the course criteria and assessment.
- The level of lecturer modeling of the pedagogical use of the tools.
- Creating a supportive learning community
- Appropriate choice of mobile devices and web 2.0 social software.

- Technological and pedagogical support.
- Allowing time for developing an ontological shift, both for the lecturers and the students.

These identified critical success factors can be compared and validated against similar success factors and principles identified by other research projects (Barker, Krull, & Mallinson, 2005; A. Herrington & Herrington, 2007; JISC, 2009a). While each of these studies and reports emphasize different critical success factors for mlearning, in general they align with the factors identified by the research herein, adding validity and rigour to these findings. Table 1 compares these critical success factors with the researcher's.

Table 1. Comparison of mlearning critical success factors

The author's 2010	Herrington & Herrington 2007	JISC 2009	Barker et al 2005
1. The level of pedagogical integration	1. Authentic contexts 2. Authentic activities 4. Multiple roles and perspectives 6. Opportunities for reflection 9. Authentic assessment	1. Active participative learning 6. Learning tasks and outcomes 7. Extends the potential for learning	1. Interactivity 2. Coordination 4. Organisation of material
2. The level of lecturer modeling	3. Access to expert performances	4. Look to their tutors for guidance	6. Motivation
3. Creating a supportive learning community	5. Collaboration 8. Coaching and scaffolding		3.Negotiation and Communication 7. Collaboration
4. Appropriate choice of WMD and web 2.0	7. Opportunities for articulation	2. Selecting the most appropriate tools for the purpose	5. Mobility
5. Technological and Pedagogical Support		5. Benefits need to be clearly communicated to learners	
6. Time for ontological shifts			

The comparison of the four lists of critical success factors indicates that most research has been put into the area of pedagogical integration, with relatively little focus on the aspects of technological and pedagogical support, and nothing on the significant time frames required for learning reconceptualisations. The researcher would suggest that this lack of emphasis upon the time required for the ontological shifts that these disruptive technologies (Sharples, 2001) facilitate is because typically mlearning projects are short-term projects and do not look at the longitudinal impact of mlearning. A noteable exception is the MoleNet study (Attewell, Savill-Smith, & Douch, 2009) whose findings are in the process of evaluation at the time of writing.

Therefore the unique findings of this research include:

1. The matching of the unique affordances of mobile web 2.0 with social constructivist learning paradigms.
2. The explicit scaffolding of the required ontological shifts in pedagogical transformation via a structured and sustained intentional community of practice model over a significant period of time.

2. EXPLORING IDENTIFIED CRITICAL SUCCESS FACTORS

2.1 The Level of Pedagogical Integration

The WMD case studies indicated the critical role of the level of pedagogical integration of the technology into the course criteria and assessment. This involves scoping and planning appropriate course activities and assessments based upon the chosen pedagogical model (social constructivism), creating pedagogical alignment (Biggs, 2003). The point of acceptance into course integration of the mobile web 2.0 tools is typically reached as lecturers realize the flexibility of learning context and feedback that these tools facilitate. Learning activities typically begin as translations of more traditional paper based activities into a mobile web 2.0 alternative (A. Herrington & Herrington, 2007). As lecturers become more acquainted with the possibilities afforded by mobile web 2.0 tools more creative learning activities are developed and integrated into the courses. A key tool used to facilitate redeveloping course outlines has been Google Docs (http://docs.google.com) for collaborative course and assessment planning between the course lecturers and the technology steward (researcher).

As a result, a design framework was developed to guide the integration of mobile web 2.0 tools into the courses. This framework was developed iteratively over the life of the research, which began in 2006 with two test projects that informed the practical implementation of the subsequent projects in 2007 to 2009. The framework table format is based loosely on that suggested by Sharples et al (2009), emphasizing that the starting point of the design process is the learning practice and chosen pedagogical framework, which then informs the appropriate choice of mediating technologies. The case studies illustrate that curriculum integration must focus on the unique affordances of mobile web 2.0 in order to create authentic learning environments (A. Herrington & Herrington, 2007). To achieve this, curriculum integration must start with the learning practice that is to be achieved (As illustrated in

Table 2), aligning and choosing appropriate mobile web 2.0 affordances with this goal. Following such a design framework will ensure that the technology is not the primary focus, or that good pedagogy is retrofitted to technology.

Table 2. MLearning project design framework

Learning Practice	**Mediating Circumstances**		
Social Constructivism	**Context**	**Technology**	**Agent**
Lecturer Community of Practice	Lecturer professional development, pedagogical brainstorming	Face to face Scaffolded using LMS Smartphone Web 2.0 services	Lecturers as peers, with researcher as technology steward
Student and lecturer Community of Practice	Pedagogical integration and technical support	Face to face Scaffolded using LMS Smartphone Web 2.0 services	Students as peers, Lecturer as guide and pedagogical modeler, with the researcher as technology steward
Collaboration	Group projects	Social networking, Collaborative documents	Google Docs, student peers
Sharing	Peer commenting and critique	Web 2.0 media sites, eportfolio creation	RSS, student peers, lecturer
Student content creation	Student individual and group projects	Smartphone with camera and microphone, content uploaded to web 2.0 sites	Student and peers
Reflective	Journal of learning and processes, recording critical incidents	Web 2.0 hosted Blog	Personal appropriation, formative feedback from lecturer
Learning Context Bridging	Linking formal and informal learning	Smartphone used as communications tool and content capturing	Student interacting with context, peers, and lecturers

2.2 The Level of Lecturer Modeling of the Pedagogical Use of the Tools

Modeling the pedagogical use of technology involves creating a Zone of Proximal Development (Attwell, 2006; Vygotsky, 1978).

> This theoretical construct states that learning occurs best when an expert guides a novice from the novice's current level of knowledge to the expert's level of knowledge. Bridging the zone of proximal development construct with legitimate peripheral participation construct may be accomplished if one thinks of a zone in which the expert or mentor takes the learner from the peripheral status of knowing to a deeper status… the expert scaffolds the environment to the extent in which the learner is engaged with the discourse and participants within the zone and is drawn from a peripheral status to a more engaged status (Attwell, 2006, p. 6).

A second aspect of modeling is socialising the everyday use of the technology, creating socially-defined ways of appropriating the technology within each unique group of learners.

The researcher sees similarities and useful alignment of our pedagogical approaches with 'pedagogy2.0', 'authentic learning' and some of the Pedagogy-Andragogy-Heutagogy (PAH) continuum principles (Luckin, et al., 2010). The key point of difference is in the role that the authors assign to the lecturer within the formal and informal learning environments. We see the input and facilitation of the lecturer as a critical success factor in implementing mobile web 2.0 technologies, and would agree with Laurillard's position that states "M-learning, being the digital support of adaptive, investigative, communicative, collaborative, and productive learning activities in remote locations, proposes a wide variety of environments in which the teacher can operate" (Laurillard, 2007, p. 172). Therefore the staged integration of mobile web 2.0 within the course closely follows the staged and scaffolded implementation of a learning paradigm that moves the students from highly teacher-directed (pedagogy) in first year to highly self-directed (heutagogy) in the third year. Therefore strategies for the integration of the mobile web 2.0 technologies into lecturers' daily workflow were developed. Taking some broad framework ideas from the Wollongong mlearning projects (J. Herrington, Mantei, Herrington, Olney, & Ferry, 2008), lecturers participating in the projects were required to fulfill several commitments (as below), and the projects were rolled out over two semesters: beginning with the continuation and expansion of established projects in semester one, (which were used as example champions) with new projects focusing initially on lecturer professional development during semester one, followed by student implementation in semester two of each academic year.

Participant (Lecturers) requirements for mlearning:

- Participation in a weekly Community Of Practice.
- Personalised integration of mobile web 2.0 technologies.
- Development of mlearning activities based on social constructivist pedagogy for implementation with students.
- Implement a semester-long mlearning project with students.

- Publish a research output based on the project, e.g. as a study paper at a conference, or in a journal, or presentation at a symposium to other staff.
- Ethics consent for the researcher's anonymous use of data.

2.3 Creating a Supportive Learning Community

Each mlearning project involved the development of a unique learning community that included: the use of regular formative feedback from both lecturers and student peers, establishing and nurturing of an intentional Community Of Practice (COP) (Langelier, 2005; Wenger, White, & Smith, 2009; Wenger, White, Smith, & Rowe, 2005), and was supported by social networking and collaboration (Wenger, et al., 2009; Wenger, et al., 2005). An intentional Community Of Practice model (Langelier, 2005) was found to be effective for guiding and supporting the mlearning roll-out to achieve these goals. This comprised weekly pre-project "technology sessions" (Community of Practice) with small groups of lecturers facilitated by an appropriate 'technology steward' (Wenger, et al., 2005). The same model was then used with the students and their lecturers in courses.

A common theme in student feedback from all the projects was their desire to receive more formative feedback from their lecturers, which they saw blogs as a suitable tool for facilitating. Additionally students valued peer commenting on their blogs. This is a culture that needs to be established early in moblogging projects. When modeled by their lecturers and the technology steward, students in the projects developed a strong sense of community and integrated the technologies into multiple learning environments, while also critiquing and collaborating with their peers. The focus moves from teacher-directed to student-centred, where students create accounts on free web 2.0 sites and then invite their lecturer and peers to collaborate within these environments, turning the control of the learning environment beyond the domain of the teacher-directed learning management system (LMS). MLearning technologies provide the ability to engage in learning conversations between students and lecturers, between student peers, students and subject experts, and students and authentic environments within any context. It is the potential for mobile learning to bridge pedagogically designed learning contexts, facilitate learner generated contexts, and content (both personal and collaborative), while providing personalisation and ubiquitous social connectedness, that sets it apart from more traditional learning environments.

2.4 Appropriate Choice of Mobile Devices and Web 2.0 Social Software

To create authentic learning environments (A. Herrington & Herrington, 2007), the WMDs mlearning affordances must be mapped to the chosen pedagogy. A central focus of the mlearning projects was facilitating student-generated content and context bridging via the ubiquitous connectivity of smartphones. To reduce the cost of WMD Internet connectivity, dual wifi and 3G WMDs were specified. To make this affordable for the participants, institutionally owned WMDs were supplied to the participants. Participants were encouraged to treat the WMDs as if they owned them, fostering a sense of personal ownership leading to appropriation and integration of the technology via socially constructed choices (Bijker, 1995; Carroll, Howard, Peck, & Murphy, 2003; Davis, 1989). This requires utilising the types of WMDs that students want to use and own. In most cases students personalised and socialised the everyday use of the smartphones beyond embracing them simply as tools to aid their learning. Student feedback from the mlearning projects clearly showed that the choice of smartphone was critically important in the acceptance of its use. This is a function of both the social acceptance (social construction) of a smartphone, and the smartphones ability to enhance the specific requirements of a particular course's focus.

In response to this a smartphone evaluation rubric was developed for choosing or recommending an appropriate smartphone for each of the mlearning projects. The rubric was used for comparative rating of several current (2009) and soon to be available smartphones according to their match with sixteen chosen affordances for mlearning and mobile web 2.0 (Cochrane & Bateman, 2010b).

Student feedback indicated that too many mobile web 2.0 options and affordances were covered in the 2008 projects, and experience has shown that students prefer to use the smartphones for activities that make use of the unique affordances of the WMDs rather than replicate what can be achieved using a standard laptop or desktop computer. Therefore specific affordances of the new generation of smartphones were focused on in the 2009 projects and beyond.

2.5 Technological and Pedagogical Support

Initial pedagogical and technical support for each mlearning project began with the establishment of a lecturer COP focusing upon investigating the pedagogical use of the tools and developing lecturer competency and personal appropriation of the tools. This was then followed by the establishment of a combined lecturer and student COP for implementing the mlearning project. The projects highlighted the critical role of the 'technology steward' (Wenger, et al., 2009; Wenger, et al., 2005) within the COPs. A strategy for pedagogical and technological support for the integration and implementation of mobile web 2.0 was developed using an intentional COP model (Cochrane, 2007; Cochrane & Kligyte, 2007; Langelier, 2005). Using this model, the mlearning projects were guided and supported by regular 'technology sessions' (COPs) facilitated by an appropriate 'technology steward' (Wenger, et al., 2009; Wenger, et al., 2005) who provided guidance to the group, while also interacting as a peer group member in this learning community. These mlearning projects therefore become collaborative projects between the 'technology steward', the course lecturers (one of whom may take on the role of technology steward), and the students on the course. The institution's LMS was then used to provide scaffolding and support for both lecturers and students. Lecturers were encouraged to model the use and integration of mobile web 2.0 in their own daily workflows and to provide regular formative feedback to students via interaction on their web 2.0 sites and eportfolios.

While very time intensive, requiring prolonged commitment from both the participants and the technology steward, the use of an intentional Communities of Practice model for creating academic peer support groups to investigate the integration of social software and elearning and mobile technologies into tertiary education has proven to be more successful and a better use of resources than general workshops for academic staff. Academics who have participated in the mlearning COPs feel better prepared for today's technology adept learners. The uptake throughout the institution of COPs for educational technology is encouraging, and leading to collaborative projects between the researcher, academics and students. Staff who previously struggled with integrating technology into their pedagogical approaches are now implementing mobile learning projects with students, and thus we are seeing the awareness and uptake of mobile technologies in tertiary learning increase at Unitec. Key to the models success is its flexibility: recognizing that every COP formed is unique, requires negotiable content, motivational goals, and appropriate access to resources. Every COP requires a different approach for nurturing and motivation. Finally, the guidance of a Technology Steward is critical in establishing and guiding each COP in their investigation and use of technology.

2.6 Allowing Time for Developing an Ontological Shift

The mlearning projects identified three key issues around reconceptualising teaching and learning (an 'ontological shift' in participants' understanding):

- Staging and scaffolding the introduction of disruptive technologies reduces students' cognitive load and maximizes the effectiveness of the zone of proximal development (Attwell, 2006; Vygotsky, 1978).
- Shifting lecturers from pedagogy to heutagogy – reconceptualising teaching (Luckin, et al., 2008; McLoughlin & Lee, 2008).
- Shifting students beyond their knowledge threshold – reconceptualising learning, and using the WMDs to engage students with "troublesome knowledge" (Land, Cousin, Meyer, & Davies, 2005).

Lecturers typically require significant time to become comfortable with using the mobile web 2.0 tools, and with the potential for enhancing their course. The various mlearning trials undertaken have illustrated that pedagogical integration of mlearning into a course/curriculum requires a paradigm shift on behalf of the lecturers involved, and this takes significant time. Hameed and Shah (2009) describe this process as a "cultural re-alignment". The research followed the learning journeys of the researcher and participants as they moved from personal appropriation of the new technologies to the ontological shifts (Chi & Hausmann, 2003) required for integrating the unique affordances of these mobile web 2.0 technologies into their pedagogical practice and courses, enabling collaborative learning environments that bridge multiple contexts. Many of the identified mlearning scenarios were serendipitous rather than planned by the lecturers during the earlier mlearning projects. It also became apparent that students also require significant time to gain the skills required to maximise the potential of new and emerging web 2.0 tools – as our pre-project surveys indicated, few students were already using these tools for their own content creation before the projects. Based upon these experiences, in order to achieve an explicit move to a social constructivist learning environment using mobile web 2.0 tools during 2009, a staged, and scaffolded approach was adopted. This staged approach allows the bridging of the PAH (Pedagogy, Andragogy, Heutagogy) continuum (Luckin, et al., 2008), and the embedding of mobile web 2.0 affordances that support each stage. A key strategy to facilitate a move along the PAH continuum (Luckin, et al., 2008) is curriculum integration of mobile web 2.0. Thus beginning the introduction of web 2.0 integration into the first year of a course (in multi-year courses) will prepare students for higher-level context bridging in subsequent years of their course.

3. IMPLICATIONS OF THE FIVE CASE STUDIES

3.1 Implications of Case Study1: Diploma of Landscape Design 2006 to 2009

Beginning in 2006 (Cochrane, 2010b), the first mlearning project paved the way for the following projects, highlighting a range of technical and implementation issues that could be improved upon. The project also emphasized the disruptive nature of mlearning (Sharples, 2001; Stead, 2006), illustrating the process of lecturer pedagogical reconceptualisation of teaching, and the process of student reconceptualisation of learning required as the course moved from teacher-centred (pedagogy) to social constructivism (andragogy to heutagogy) (Luckin, et al., 2008; McLoughlin & Lee, 2008). Thus the importance of a robust yet flexible technical and pedagogical support strategy was highlighted. The unique student profile (all the students were aged between 43 and 69) of the 2008 iteration of the Landscape Design mlearning project highlighted the importance of choosing appropriate WMDs for the needs of each unique student group. Thus the 2009 Landscape Design mlearning project used netbooks to minimize the cognitive load for the students (Kirschner, 2002; Valcke, 2001), and highlighted the importance of learning community formation to be integrated into the course.

3.2 Implications of Case Study2: Bachelor of Product Design 2008 to 2009

The Product Design mlearning projects achieved significant progress in course integration, pedagogical reconceptualisation, and development of a staged and scaffolded implementation model for developing learning communities facilitated by intentional communities of practice across each year of the course (Cochrane & Bateman, 2010a). The case study illustrated the potential to stage and scaffold mlearning integration across all three years of a Bachelor level course, starting with establishing a learning community culture involving both the students and the lecturers and facilitation of a progression of teaching paradigms from pedagogy to heutagogy (PAH) (Luckin, et al., 2008) following the first year to third year of the course. The PAH continuum maps well with the progression of mobile web 2.0 course integration from web 2.0 appropriation (JISC, 2007, 2009b) in first year to student mobile facilitated content creation (Bruns, 2007; JISC, 2009a) in second year, and finally the context independence and bridging affordances of mlearning (Luckin, et al., 2008; Vavoula, 2007) leveraged in the third year 'nomadic studio'.

3.3 Implications of Case Study3: Diploma of Contemporary Music 2008 to 2009

The Diploma of Contemporary Music mlearning project developed from an initial exploration of the potential of mlearning to engage students and enhance the course to an example of successful course integration and student adoption and appropriation of mlearning. During the first iteration of the mlearning project students and lecturers were enthusiastic and engaged by the tools, but skeptical as to the potential impact on the course and learning outcomes (Cochrane, 2009a). The second iteration of the mlearning project integrated the mlearning tools into the course assessment leading to adoption and appropriation by the students beyond personal and social use, leveraging the learning context bridging (Vavoula, 2007) affordances of mobile web 2.0 for facilitating authentic (A. Herrington & Herrington, 2007) course-related learning environments beyond the classroom. This case study also demonstrates the need for significant time for lecturer pedagogical reflection for the necessary ontological shifts (Chi & Hausmann, 2003; Hameed & Shah, 2009) in their pedagogical conceptions to be able to integrate mlearning authentically.

3.4 Implications of Case Study4: Bachelor of Architecture 2009

The Architecture mlearning project was the widest scoped in terms of student numbers, encompassing the entire second year of the Bachelor of Architecture (115 students). However the project was a first implementation within the school, and formed an exploratory initiation into the potential of mlearning for both the lecturers and the students. This illustrates a consistent theme in all of the mlearning projects, that the first implementation of an mlearning project breaks new ground, and while not necessarily producing significantly transformed pedagogy due to a lack of course integration, the first iteration creates the groundwork for the ontological shift (Chi & Hausmann, 2003) required by the course lecturers to conceptualise the potential to integrate the technologies into the course in subsequent iterations of the mlearning project. Key lecturers declined to be involved in the establishment of the initial lecturer investigative community of practice, leading to a lack of willingness to integrate the project into the course assessment. This case study therefore highlights the critical importance of lecturer professional development and subsequent course integration of the mlearning tools. This is the first significant step in the journey of ontological reconceptualisation of teaching by the lecturers, and the ontological reconception of learning by the students that the mobile web 2.0 projects have been explicitly designed to facilitate. The lecturer's input into the design of mlearning is critical (Laurillard, 2007).

3.5 Implications of Case Study5: Bachelor of Performing And Screen Arts 2009

The Performing and Screen Arts mlearning project was one of the most ambitious of the mlearning implementations with regards to the use and exploration of the mobile technologies. However, its implementation suffered from the relatively short time the lecturers had for personally appropriating the mlearning tools themselves, and timetabling limitations led to a significant change in the community of practice support model. While not personally modeling the use of the mobile web 2.0 tools to a high level, the course lecturers nevertheless created an atmosphere of high expectations of the students that created an energetic 'buzz' among them, facilitating experimentation and collaboration around the use of the tools. While there was a lack of course-focused community facilitated by the WMD implementation, there was a very high level of personal appropriation of the WMDs by the participating students. Students found the portability and ubiquitous connectivity of the smartphones empowering for both accessing course content and their social networks. This case study therefore highlights the importance of the development of a regular supportive learning community, and the positive impact of high expectations from the lecturers on the participating students.

4. DISCUSSION

While the research has sought to produce transferable principles and strategies to enhance tertiary education using mobile web 2.0, it is ultimately bound by the limits of the contexts of the learning communities that it is embedded in (the five case studies are based in the 'creative arts and industries' fields), and the current affordances of the available mobile web 2.0 technologies. The mobile web 2.0 projects have so far used a model of providing a common smartphone for the students and lecturers within a course. The students and lecturers involved have been encouraged to use the smartphones as if they owned them for the period of the projects. This approach was used to seed the concept and provide proof of concept results. However, to create a sustainable approach, the goal going forward is to move to a student-owned model, where students purchase a smartphone that meets specifications outlined by the course requirements, much as many institutions currently require students to purchase a specified laptop computer to ease support requirements. As the cost of appropriate smartphones and 3G data costs drop, the purchase cost may be sustainably subsidized by institutions in lieu of other course related costs that the mobile web 2.0 paradigm replaces. However it is yet to be seen whether there can be transferability of the research outcomes based upon an institution supplied or specified WMD and mlearning projects based upon student chosen and owned WMDs (Traxler, 2010).

The technological goal-posts of mobile web 2.0 are rapidly changing, and new integrated smartphone affordances continue to provide new ways of communicating, collaborating and enhancing learning. An example for future research is the rise of augmented reality applications for smartphones and integration with web-based services. The challenge is to implement these new technologies from a sound pedagogical basis.

An intentional community of practice model provides a sustainable framework for pedagogical and technical support of mlearning projects. While it is time-consuming, the results are rich. "The community of practice is one way to manage knowledge. It is a powerful, but demanding tool" (Langelier, 2005, p. 8). The COP model has led to the development of mutually collaborative partnerships that have seen rewards in increased student engagement, deeper pedagogical reflection, and practice-based research outputs. The symbiotic relationship developed between the researcher (technology steward) and the lecturers involved in each of the mobile learning trials overviewed has proven to be a rich environment for harnessing mobile web 2.0 technologies to design social constructivist learning environments for different groups of tertiary students. The disruptive nature of mobile web 2.0 technologies has been presented as a catalyst to move traditional instructivist pedagogies towards social constructivist pedagogies that bridge both on and off campus learning contexts.

A limitation of the participatory action research methodology of the research is the significance of the input of the researcher as the technology steward for the projects. The partnerships developed between the researcher and the participants (particularly the lecturers) have been critical in supporting and providing direction for the projects. It is yet to be seen whether the approach can be transferred to other mlearning contexts involving a different technology steward.

5. CONCLUSION

Mobile web 2.0 is a continually evolving environment with new technologies and affordances developing at an astonishing rate. However this research has illustrated that by identifying and putting in place strategies to support mobile web 2.0 critical success factors it is possible to transform teaching and learning.

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User-centric Developments

Full Papers

Comparing the Emancipatory Value of two South African Mobile Learning Projects

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Abstract

This research compares the emancipatory value of two mobile learning projects in diverse South African socio-economic contexts. This is done by applying Critical System Heuristics (CSH). The application of CSH to the two mobile learning projects results in a list of emancipatory values, including potential, realized and desired values as well as barriers towards realizing emancipatory potential. Similarities and differences are then identified and compared for the two projects.

The study points towards "inherent" emancipatory potential of mobile learning but concludes by indicating other socio-technical factors as necessary conditions for emancipatory value to realize.

Keywords

Mobile learning, emancipatory value, emancipatory potential, socio-economic contexts, Critical Systems Heuristics.

1. INTRODUCTION

SA is a third world country but with strong first world elements included in it. The empowerment and emancipation of the socially and economically excluded population of the country is of great importance to the ruling government. Emancipation implies empowered people who can not only identify impeding barriers, but can also appreciate and change their situations to free themselves from the bondage of these barriers, and thereby become liberated (Davidson et al, 1998: 310). Education can emancipate people to change and improve their circumstances and free themselves from the influencing or impeding powers in their lives through the building of improved capacity for interpretation and understanding. Investment in education is considered important, as education is a powerful tool to enhance social and economical development (UNESCO, 2003: 1). Education can therefore be seen as a road towards the empowerment and emancipation of citizens of a developing country.

The ease with which South Africans adopt mobile technology suggests a wide range of possibilities for education using mobile technology. (mobile technologies have an estimated penetration of 83 percent of the population in SA (Integrat, 2008: 1)). Mobile technologies have been described as having "unique capabilities" for education (Squire, 2009: 70) and to realise the potential of these mobile technologies will require additional investment in education (Farrell & Isaacs, 2007: 29). However, the emancipatory impact that mobile technologies can add to education through mobile learning is unclear. This is where the contribution of this paper lies.

2. RESEARCH PROBLEM

South African private schools and mobile learning application development companies are taking the lead in exploring the educational opportunities of mobile learning, with government schools lagging behind. (Eicker & Matthee, 2008: 37). Government schools accommodate a very diverse part of the population. Some government schools cater for the wealthy, others cater for the less privileged (often the schools in rural areas), and some for both. This research is built around two mobile learning projects; one from a private school and another from a government school situated in a rural area.

The focus of this paper is therefore on the following questions 1) how does the emancipatory value of mobile learning compare between the mobile learning projects? 2) what is the emancipatory potential of mobile learning?

The next section gives an overview of Critical Systems Heuristics (CSH).

3. CRITICAL SYSTEM HEURISTICS

CSH was developed by Ulrich in 1983 as a critical approach to systems thinking (Donaires, 2006). It represents a first systematic attempt at providing both a philosophical foundation and a practical framework for critical systems thinking (Ulrich, 2002a). Ulrich argues that all system designs should be subjected to critique and critical inspection (Flood and Jackson, 1991), as there is no single right way or absolute truth (Midgley, 1997). CSH is informed by the Kantian concept of selectivity - when we refer to the 'whole' system of concern we are inevitably selective in our presumptions related to the boundaries of the 'whole' system (Flood and Jackson, 1991). Inclusion and exclusion are therefore decided and influenced by the system designer's presumptions and frame of reference. CSH is a practical method that critically explores and explicates the boundary judgments we make when we deal with social systems.

Critically handling the boundary judgements that permeate the "to be" purposeful system is the methodological core principle of CSH. Therefore when assessing a system, people should be aware that the observed facts and the values deemed appropriate are bound to personal reference systems of individuals. For this reason if we change our boundary judgements with concern to the system of relevance, thus changing what is inside the system and what is excluded, the facts and values we consider will consequently also change (or vice versa) (Ulrich, 2000). There is thus interdependence between what we observe as facts, what values we use to evaluate and the boundary judgements we implicate for the system.

To employ the CSH approach Ulrich developed a conceptual framework containing twelve boundary questions. The framework consists of four basic boundary issues which in turn lead to three types of boundary problems. Assessing the merits of the propositions of the relevant reference system, the boundary questions include those involved and those affected but not involved. The first three issues are directed at those involved and the fourth at those affected but not involved.

The four boundary issues are related to the bases for (1) motivation – i.e. the sources of a sense of purposefulness and value; (2) power – i.e. the source of control related to continuity and success; (3) knowledge – i.e. the support base of experience and expertise; and (4) legitimacy – i.e. source of legitimation. (Ulrich, 2005).

When a claim is made, its "anatomy of purposefulness" consists of a combination of the four boundary issues (Ulrich, 1983). Critical heuristics proposes that these four issues are "*essential for reflective practice in most (if not all) situations of problem solving, decision-making, or professional intervention*" (Ulrich, 2005). Each of these issues addresses three categories: (1) involved and affected stakeholders; (2) role-specific concerns associated with each stakeholder; (3) key problems and measurements of improvement (Ulrich, 2000, Ulrich, 2005).

These boundary categories combined with the boundary issues constitute the conceptual framework for the twelve boundary questions used in the CSH approach. CSH poses these questions in both the "is" mode as well as the "ought to be" mode. Comparing these bring out the normative content (Flood and Jackson, 1991) of the system under investigation and the unresolved boundary issues revealing the selectivity of the system of concern. There is no one right answer and therefore the boundary judgements may always be reconsidered (Ulrich, 2000).

Considering the system of concern from multiple perspectives allow understanding of how claims can be understood differently when sought from another frame of reference. When considering the boundary judgements from various involved and affected stakeholders, it might become clear why social systems do not always achieve their aims. The CSH approach therefore promotes the idea of professionals being openly aware of their boundary judgements and being open to critically reviewing these. (Ulrich, 2000).

3.1 Critical System Heuristics and Emancipation

CSH considers its problem of concern socio-technical systems (Daellenbach and McNickle, 2005) with an explicit focus on emancipation (Ulrich, 2002b). Referring to the polemical employment of the boundary questions, CSH can assist people in becoming competent citizens who can engage in rational debates and make their voices heard (Daellenbach & McNickle, 2005: 198). They can challenge the systems rationality (Flood & Jackson, 1991: 198). by using CSH to reveal the values, facts and judgements that went into the actual and proposed systems designs. "Although this is no guarantee of complete emancipative success, there are numerous instances where the concerns of citizens, repeatedly and insistently raised in the public sphere, have finally prevailed" (Daellenbach & McNickle, 2005: 199).

CSH has been used to indicate the flaws and judgements of the systems of concern and as a tool to emancipate those affected, but it has not been explicitly used to indicate the emancipatory value of a system. It is for this purpose that it has been applied in the mobile learning projects described by this paper. The next section describes the approach that was used to accomplish this.

4. METHOD

The research used a critical view to identify these restrictive and alienating conditions and combines this with an interpretive view aiming at understanding these conditions from the views and interpretations of the people involved in the research.

The case study approach was used to identify and describe the context of the mobile learning projects. Through field trips and observations, the researcher gathered information to describe the two case studies, named Project A and Project B. These two case studies are representing two divergent socio-economic conditions of secondary schools in South Africa. Critical System Heuristics (CSH) was used to guide and interpret the interviews which were conducted with participants on the mobile learning projects. Both settings will now be explored in more detail after which the data collection method will be explained

4.1 Project A

The mobile learning project was initiated by a publishing house in cooperation with a mobile learning application developer. The publisher provided text books covering the mathematics curriculum from Grade 10 to 12. Videos containing visual and audio illustrations of some examples were made available for downloading through the mobile learning application platform as an extra source of information complementing the textbook. The aim of the mobile learning aspect was to assist and enhance the learning experience of the learners and not to replace classroom learning. The publisher and developer visited the school at the beginning of the project to explain and demonstrate the mobile learning platform in terms of how to access and download the recordings. The learners and teachers were all given free access and downloading rights for one year.

This project took place in a government school in a rural area in Mpumalanga, one of the provinces of SA. All of the learners and teachers at the school have access to a mobile phone while the majority of them own their own mobile phone. There is a computer lab with two PCs available for learners to use under supervision. Strong safety measures are in place to secure the safety of the PCs. There is a PC in the principal's office with no Internet connection and which is used infrequently. The majority of the school's learners do not have computers at home. They do however use their phones to connect to the internet to occasionally download music, ring tones or games. The mobile phones are thus very popular amongst the learners and most of them have fairly new models. The teachers however own older types of mobile phones and mainly use them for phoning and SMS. Only one teacher has a 3G modem which he uses to access the internet (for browsing and emailing). He is also the only teacher with an email address.

4.2 Project B

This particular project was done at a private school in a high income urban area Pretoria, Gauteng, South Africa. All the learners and teachers own at least their own mobile phone. These learners and teachers have been repeatedly exposed to and frequently make use of computers and the internet at school and home. Students have the option in some classes to hand in their assignments and receive feedback electronically. They are generally very well acquainted with technology and it has become an integral part of their daily lives.

In the grade 11 Life Sciences class the learners started taking photos of the dissection process for study purposes. They then got the idea to document these types of lessons according to the learning objectives of the Life Sciences curriculum with the aim of sharing this with learners with less exposure and resources.

The teacher took up their idea and transformed it into an assignment or task. Due to time limitations learners were instructed to do this after school hours using their own resources. The learners wanted to combine the content of Life Sciences with the concept of fun learning. They thus made use of videos, photos, recordings and illustrations to compile the content they wanted to share. They used mainly their own mobile phones, although other technological devices were also used, such as personal computers (PCs) to compile and edit the footage, and digital cameras for improved footage.

The main aim was then to transform these videos or content packages into something that could be downloaded onto or shared via a mobile phone. Their assumption was that learners who wanted to use this resource would have greater access to mobile phones than PCs with Internet connectivity. The teacher helped the learners to find a suitable converter. The content packages were compiled by the learners and converted into formats for different phones. They uploaded these onto a Department of Education (DoE) website (Thutong portal) from where it can be accessed by any learner.

4.3 Interviews

The practical framework of CSH consists of twelve boundary questions which had to be answered by as many of the involved or affected participants as possible.

Semi-structured interviews were set up as the researcher had to restate or add questions to clarify the meaning, thus changing some of the originally stated questions. These semi-structured interview questions were developed according to the participants with whom it was conducted. It was therefore divided into two sets of questions, one directed at the publisher and developer of the mobile learning project and the other at the teachers and learners. It was important to get interviews with as many of the involved and affected participants to display the various perceptions and views as proposed by CSH.

The interviews with each group identified above were done individually. The publisher and developer in Project A were also interviewed separately as they are from two different companies. As explained in the case study Project B, the learners and the teacher play dual roles, fulfilling the role as the developers as well. Both sets of interview questions were asked to both the teacher and the learners involved on this project. Due to time limitation of all the interviewees, the learners were interviewed as a group. It was found that the learners felt more relaxed in a group and elaborated on each other's answers. The group of teachers from Project A was handled similarly.

5. FINDINGS

Included are explanations of the barriers overcome, identified or enforced for each project. It must be noted that the scenarios listed below do not necessarily imply realized emancipatory value. It means that the value was identified through CSH as a potential value, a realised value, a partially realised value, a desired value, or it was identified in terms of what restricted or limited it from being realised. The scenarios are organised according to the four boundary issues of CSH for each individual project, namely: the sources of motivation, power, knowledge and legitimacy.

5.1 Project A

5.1.1 Sources of Motivation

Developers explored the opportunities of mobile technologies: The publisher used mobile technology to broaden his reach by using it as support to the provided text book.

Financial constraints between the learners and developers: Students did not want to use the mobile content because of financial reasons "If it was cheaper we will access it" (learner): Teachers also identified cost as one of the reasons why students did not use it “They promised to give the learners airtime, but they have never” (teacher). The fact is that they have been provided with free access to the mobile component and they received the books for free. It remains unclear why the learners did not know this. Only one student understood the conditions, embraced the project and is now sharing this knowledge with other learners.

Teachers assumed some of responsibility and started to change their situations. The teachers are adjusting the project to their needs by giving the extra text books to other grades. “We have already given some of the books to the Grade 10s. The project must grow” (teacher).

5.1.2 Sources of Power

Power relations in terms of authority: Decisions made in the publishing company regarding the project were made in a bureaucratic fashion: The project was assigned to a person other than the one with the initial initiative and vision. It was then reassigned again after that person resigned. “Maybe if they kept the visionary in charge [it would have been more successful]” (Developer). The power relation between the publisher, developer and the Department of Education (DoE) is also worth mentioning. The DoE oversees all the educational programs, including this one to do quality assurance. The DoE also holds the power to grant someone such as the developers the permission to perform a project at any government school in South Africa. It is thus necessary to include and involve the DoE because they have the sole power to appoint the school. The developers had no say in this decision.

Power relations in terms of decision making: In the same way the publisher and developer had no authority to enforce participation in the project. The DoE on the contrary has the power but did not exercise it.

The importance of a project champion: The school is located in a rural area making regular visits by the developer and publisher difficult. The developer expressed his opinion that “it’s not working because there is no local champion at the school making sure of the improvement, especially considering that the school is so far away from all of us” (Developer).

5.1.3 Sources of Knowledge

The initiators had limited mobile learning application experience: The publisher with no previous experience with mobile learning projects was in charge of most of the decisions and the approach used. The developer, who had relevant prior experience, controlled only that of the technical platform they provided. This was however a pilot project through which both the developers wanted to learn.

Lack of knowledge about project and continuing guidance. Students considered the one demonstration they received on how to use the technology and books, as inadequate. “Actually if you have all the information and you don’t know how to use it, you’re not going to use it” (learner). Through this the learners expressed their need to understand what they are being given and why they are being given the information. The learners expressed their need for someone to guide and evaluate their use of the project. “We are teenagers, they should return to see how we are doing” (learner).

Learners and teachers experienced a lack of exposure and access to technologies The learners who did not use the mobile learning component revealed that they either do not have access to such technologies or do not know how to use it. “It is a great idea, but then people don’t know how to use such technology” (learner). “Most of the teachers don’t even know how to use the internet and most learners also don’t have access to such technologies, although almost everyone has phones” (learner). They did not consult us so that we can understand what we are supposed to do” (teacher) Mobile learning only requires a phone that can access the internet which most of them already have. The technology here is seen as a boundary rather than a liberator. It could be that because they are not constantly exposed to technology they do not feel comfortable using it, but they definitely feel comfortable using more familiar functions on their phones.

Success measured by uninvolved body of authority: “We have a top class management team making these decisions. I am sure that their measures (the measure of improvement) will be appropriate” (publisher). A team of experts was given the power to determine the success of the project, although they never visited the school.

Increased access to more sources of information through the mobile learning project for the teachers and learners: The boundary this mobile learning project shifted was the one confining the teachers and learners to limited sources of information at their disposal. They were given extra sources of information. “I think it helps a lot to source for extra information if we maybe don’t understand and we become more confident in our teaching. When the teacher is not sure on how this thing works then the learners become reluctant” (teacher). The situation is similar for the learners who could now consult the book or the mobile content in addition to their original textbooks and teachers (who they often do not have confidence in). “There are topics of which the teachers are, you can say afraid of. And you can use this book to understand and the teachers as well” (learner). Those who use the mobile learning together with the book now have access to a personal tutor which shifts the boundaries of accessing more information at any time in any place. “It’s effective and it’s a good way of learning because I have a tutor at home to help me with difficult subjects” (learner).

Learners learned how to explore, use and share knowledge without facilitation: One learner managed to master the technology and used the resources effectively. She shared the knowledge with others. She is thus helping herself and extending it to others motivated by this project.

A need for more exposure and contact with other people: “It’s also nice to get people visiting the school” (learner).

The teachers and learners feel motivated by people coming to visit their school and helping them by giving them such a project. "It encourages us and the learners when they bring the projects" (teacher). The learners have a need for more exposure to the outside world.

Traditional teaching styles: "And the problem I think is that teachers have adopted their own way of teaching, so now you bring something new, they tend to take long to adapt" (learner). Learners are of the opinion that the familiar teaching styles of teachers stand in the way of adopting new ways of teaching.

5.1.4 Sources of Legitimation

Learners expressed their need for increased communication and feedback: Learners expressed a need for two-way communication between the initiators of the project and themselves. "They must give us a way to communicate with them to say our views" (learner). "It's cool! You can go onto the internet and download things and talk about it, and have your own online tutor, but maybe if we could talk to them like Mixit or Facebook. But if they can maybe come up with a way that you can post a question on the internet for them to answer" (learner).

Teachers felt reluctant or powerless to raise their voice: Despite the fact that the teachers were invited to make use of a given phone number and an email address, they did not utilise it to contact the developers. The teachers said all they can do is to make suggestions, "but I do not think we have more powers to do" (teacher).

Teachers felt restricted by their level of knowledge: The teachers are determined that the developers should have given them a proper introduction and some training about the book and the mobile learning as they do not feel equipped to do it on their own. "They did not consult us so that we can understand what we are supposed to do. They could have some workshops before they come and give this project to us" (teacher). The teachers' lack of knowledge about mobile technologies and mobile learning restricted their use of the mobile learning component.

Learners felt more knowledgeable than their teachers: The learners do not show any signs of being inspired by their teachers' knowledge or abilities and they actually feel more powerful than them in terms of learning and technology. "The mobile learning, I don't think a lot of them [teachers] are using, because…we are more advanced with technology" (learner). They need someone more knowledgeable about mobile technologies than themselves, and their teachers are not fulfilling this role.

Awareness of the importance of mathematics for opening new opportunities for learners and teachers: The teachers understand the analytical importance of Mathematics. They see that those who do well at Mathematics also do well in other areas or subjects. This project highlighted this need for Mathematics even more, making them even more conscious and motivating them to work even harder. "We got the project because we have a large number of learners who are taking Mathematics and that makes the officials think this school is good" (teacher). I

Developers assumed the needs of the teachers and learners: The initiators of the project did not determine the needs of the teachers and learners beforehand. "I think before they came they should have conducted and come to us and see what we actually need, and not assume" (learner). They used their dominant position to include only what and who they thought to be appropriate. "We assume there is a need for better Mathematics education, and then we pitch up there with the project and then leave" (developer). The publisher however describes the project as being a collaborative process.

Developer realised the need to design solutions to fit the real needs of the users

"Ice cubes are for people that has the luxury of not being thirsty, because when you are thirsty you just want water not ice cubes!" (developer). The developer thus learned from this pilot project that the clients' or users' needs are important to know and include in mobile learning projects, shifting the power barrier and emancipating himself through this project.

5.2 Project B

5.2.1 Sources of Motivation

The liberating and motivational effect of sharing knowledge: The learners had to share their knowledge with each other and then wanted to share their knowledge with learners outside their own context. The teacher directed this by teaching the learners: "You as an individual, who are powerful, you've got all this knowledge and you don't need to keep it to yourself" (teacher). One group even went as far as going to a hospital to show the nurses their mobile learning artifact with the intention of sharing their knowledge with someone without the same opportunities. "We knew we were sharing with them and at the same time benefited on a personal level, knowing that we can help out" (learner).

Experiencing the value of teaching as a learning technique: Exploring the content of a subject with the aim of explaining it to someone else, gave them the experience of learning how to teach, promoting the development of their own learning. "It was actually to enhance our learning ability and to understand the greater scope of the topic and then it had further applications from there" (learner). They now know more about their own learning styles, strategies and ways to convey information in an educative manner.

The importance of two-way communication with the intended user: When they put the information on the Thuthong portal, the control over who can access the information was taken out of their hands. And with no feedback mechanism built into the technology used, it is not possible to know how many other learners accessed or used it. The project did however attract unexpected users, who got in contact with the teachers and learners to learn from them, thus teaching them the importance of various methods of communication and the role of getting feedback.

Teacher's innovation inspired learners and other teachers: The teacher inspired other people through experimenting with mobile learning in her own classes. Through this she consciously empowered the learners to the extent of personal and professional growth and achievement. "I think it wouldn't have been successful if we weren't sitting here, I think we can use this to measure it. It started as a class project and it's gone far from that till now and everyone can use it. Also get feedback from people who are incorporating these ideas now" (learner). On top of this she extended this empowerment to other learners and teachers from other schools.

The educational opportunities provided by mobile technologies: The mobile learning project introduced and exposed them to different ways of teaching and learning and the opportunities technologies hold for education. "Making the whole experience more visual and audio. It's almost like someone is teaching it to you, you don't read it off a page. We did it now by using the computers and our cell phones. Just to communicate what we have learned in a different way, and not so much mundane in a book type of thing" (learner).

5.2.2 Sources of Power

Encouraging a more flexible and liberating teaching and learning environment: The learners had the freedom of choosing the technologies and software they wanted to use, although the teacher introduced them to one program as an example. The learners experienced learning without fixed guidelines but by relying on their own initiative. They shifted the possible barriers of technology by exploring and learning about the technology and in the end using it to their advantage as well as for other's benefit.

The project guidelines were negotiated with the teacher as the project progressed. "It was quite interesting because you wouldn't know where it's going. We often changed when something new came up and then we think oh, or this way we can log this or go there…" (teacher). This necessitated a flexible approach and attitude from both the learners and the teacher. "doesn't work, or they can't see this etc. Very storming and norming" (teacher).

The teacher was also experimenting with this project and therefore allowed the learners to form their own interpretations through application. This taught the learners how to use their own interpretations when the guidelines are not set. The learners became more confident about their own thinking.

The development of new technologies encouraged a more facilitation type of teaching approach: The teacher and learners claim that they have learned more because of fewer restrictions being placed on the learners by the teacher. ". I would never put limitations on learners anymore. I would work without boundaries, other than deadlines. Because we don't know where technology is going. We don't know the capabilities. And if you limit them, you don't know" (teacher). The teacher realised that her knowledge becomes limited as technologies keep evolving

.Shift of responsibility and authority from the teacher to the learners through group work: "At first we didn't have a say in it, we had to do it for the assignment" (learner). But then through forming their own groups the teacher gave them powers of authority and they learned how these can influence their work. "But we could choose our own groups, which allowed us to choose the people who you work well with and [have] good dynamics, play to your strengths. The main thing is being able to choose your own groups" (learner). The groups consisted of learners with different sets of skills and the learners had to learn how to manage this.

Challenging traditional educational systems: "I had to manipulate the class time and syllabus, which was not anticipated. It was a whole learning process, very organic" (teacher). The teacher exposed the learners to theories about technologies in education as well as referencing and plagiarism. She also had to manipulate class time to teach the learners the extra skills and expose them to more knowledge. The project took more time than anticipated and the learners had to work at home.

Empowered learners overcame the barriers that can result because of technologies: The learners learned how to overcome the limitation that their own knowledge about technologies potentially places on their education. They approached it as a challenge and learned that they had the power to explore and learn about unfamiliar things and share this with others. "Half the class didn't even know computers and Power Point and it was actually quite cool how we learned through the process. You don't know how to use this program but you figure it out on the way (learner).

5.2.3 Sources of Knowledge

Mobile phones are an integral part of the learners' and teacher's lives: The school embraces mobile phones and made it part of their lives at school as it were already part of their social lives, which did not create a limit on the use of cell phones for the learners. The teacher holds a Masters degree in Computer Education. Her knowledge about technology and education equipped her to start such a project. The learners are also very advanced in terms of technologies as they have been exposed to different technologies throughout their lives. The opportunity was then created for the teacher and learners to learn from each other. "And also because they are so clued up and so far advanced, they (are) far ahead of me with [regard] to technology but it's not a threat, it's a symbiotic relationship, I learn from them, they learn from me. I might have the content knowledge but they have more technological savvy" (teacher).

*Learners were familiarised with mobile technologies :*The teacher used the mobile technologies they were already using, and taught the learners more ways the technology can be used. The learners learned how to use the different capabilities of the technologies they had previously been exposed to, to satisfy their requirements. This familiarisation gave the learners a sense of confidence to approach technologies in the future.

Teacher and learners used their own knowledge about mobile technologies and how it can be used for education to help themselves and others: The teacher is familiar with the possibilities that technology holds for education and thus implemented this project with prior relevant academic knowledge. Mobile phones became part of the classes as the learners started taking photos of practical classes. From this the idea grew into a mobile learning project, thus utilising the current knowledge and ways of the learners and combining it with the possibilities that mobile technology and mobile learning present to expand their educational experience. "The target audience was underprivileged learners without access to textbooks and we wanted to convey all the aspects of the textbooks through these projects" (learner). The learners made use of their privileges to extend their knowledge to others without similar privileges.

The teacher learned how valuable it is to empower the learners: The teacher learned how the learners grow when she gave them more responsibility but with some direction. She sent a group of the learners to a conference to present their project which they did with great success. "It was really a sense of achievement, just to empower these children to such an extent that they have so much self worth and… that they can do that. That's amazing" (teacher).

5.2.4 Sources of Legitimation

Learners became aware of their own position in terms of access to technology: "We had access to a lot of technology and a lot of benefits. If we didn't have the access to digital cameras, scanners and computers then we wouldn't have been able to work" (learner). "We knew that it must be on cell phone, because everyone doesn't have computers" (teacher).

The learners' personal development and perspectives changed: Through this mobile learning project the teacher observed how the learners had undergone some cognitive and personal development in terms of their perspectives, confidence and how they are likely to approach things in the future. "But just their own personal growth is phenomenal, their awareness of how learning takes place, how powerful I am as an individual, in my future I'm never scared of anything again, technology wise, that fear they've overcome, they are fearless." (teacher).

The teacher exposed learners to mobile learning and connected them with the outside world: The project created the opportunity for the learners to start sharing their knowledge with others. The teacher enabled opportunities to connect the learners with the outside world to apply and share their experience and knowledge of mobile learning with the Council for Scientific and Industrial Research (CSIR), with multiple educators at a national conference and by letting them participate in the G20 summit, which the learners did willingly.

5.3 Comparing project A and project B

Table 1 below shows a summary of the differences and similarities identified between the two projects with respect to barriers towards emancipation and realized emancipatory value.

Table 1. Similarities between project A and B

Similarities
Educational opportunities provided by mobile technology: *"tutor at home"* *"video and audio material – different from text books"* *Sharing or knowledge (group work)* *Explorative learning without facilitation*
Enthusiasm of teachers
No two-way communication between project initiators and intended users
Awareness of project initiators that intended users should be involved in the design of the project

Table 2. Differences between Project A and Project B

Project A	**Project B**
Perceived financial constraints	Financial constraints not playing a role
Strong bureaucratic relations between project initiators	Shared authority between project initiators
Success measured by uninvolved body of authority	Success measured by organic growth or project
Inadequate knowledge of mobile technologies (learners and teachers)	Adequate knowledge of mobile technologies (teacher and learners)
Limited training was received wrt the project	Learners were familiarized with mobile technologies necessary for project
Lack of exposure to outside world	Deliberate exposure to outside world
Traditional education systems a lim	Manipulating traditional education system to fit the project
Strained teacher/learner relationships	Symbiotic relationship between teacher and learners
Absence of project champion	Strong project champion

6. DISCUSSION

The two said projects differ not only with respect to the socio-economic settings. The ways in which the projects started and evolved are very different. Project A was initiated by a publishing house cooperating with a developer and DoE. The project was implemented in a top-down fashion. Project B on the other hand, grew out of the innovativeness of the teacher and learners. A comparison between the two projects with regard to emancipatory value or potential of mobile learning is therefore limited. However, table 1 indicates that mobile learning facilitates knowledge sharing, explorative learning and learning outside the classroom irrespective of context. It also challenges the rigid structure of traditional education systems. It is clear though that the level on which this "liberation" takes place is strongly influenced by other factors, including the presence of a knowledgeable project champion, effective communication between learner, teacher and project initiators and adequate knowledge of the mobile technologies. These factors seem to be necessary conditions for successful mobile learning projects especially in a developmental context.

7. CONCLUSION

The findings of the study are not surprising: project A is clearly a failure and project B an obvious success. The reasons for this are also obvious. The authors are of opinion that the use of a different lens (not CSH) could however, highlight the unintended consequences and the "bricolaged" situations that occurred. Ali and Bailur (2007) argue for a move away from the emphasis on sustainability in ICT4D projects towards openness for improvised situations. What do we make, for example of the fact that learners in project A were just happy that someone came to visit their school? Was just the fact that a project was implemented at their school not already emancipatory? Or that the teachers considered the project successful because they now had text books to give the learners in the earlier grades. Or the surprising enthusiasm and involvement from parents in project B? A theory like Actor Network Theory may prove more useful in understanding the subtleness of the effects of the implementation of the project instead of only looking for the obvious indicators of success or failure. In this way we may discover unexpected examples of emancipation.

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A Framework to Guide and Structure the Development Process of Mobile Learning Initiatives

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Abstract

Mobile learning has yet to move on from small-scale trials to sustained deployment. One reason for this is the highly complex and multi-disciplinary setting that the initiatives operate within. They must deal with a wide range of issues such as software, hardware, people, learning, organizations and so on. At the same time, there is little support, as few frameworks to guide the development process exist. This article presents one such framework that was developed based on theories from software and systems development as well as practical experience from mobile learning. The framework divides the development into four Areas of Concern and introduces a life cycle of the mobile learning initiative. It further offers means to guide the development and scaling of the initiative and to find key issues that needs to be addressed in order to achieve sustainability. The framework presents a holistic view of mobile learning and is designed as an aid to all practitioners in mobile learning, no matter their background.

Keywords

Mobile Learning, Framework, Systems Development, Sustainability, Scalability

1. INTRODUCTION

The advance of information technologies and their adoption and integration into a wide variety of educational settings have allowed for the field of mobile learning to grow to a set of significant activities in schools, work-places, museums, cities, and rural areas around the world, as acknowledged by Sharples et al. (2009). The focus on mobile learning has increased in recent years, and it has lead to many research endeavors aiming at designing, developing and deploying mobile technologies to support learning, according to Taylor et al. (2006). The current mobile and wireless technologies have reached a level of maturity and ability that makes it possible to support a wide variety of learning activities.

However, a major concern is that few of the mobile learning initiatives, and mobile learning systems that follow, are ever developed into actual learning aids that are in wide use (Keegan, 2005). Traxler and Kukulska-Hulme (2005) state that in order for mobile learning to prove its educational and scientific value, more initiatives need to mature and launch mobile learning systems that are used consecutively and can be evaluated properly. Naismith and Corlett (2006) present a retrospective look on the articles published at mLearn 2002 to 2005, and they find several challenges related to development and integration of mobile learning into a setting. These challenges stem from the inherently complex environment that mobile learning initiatives operate within. If the context is not understood well enough, the mobile learning system will not survive beyond the scope of the initiative and the project's end-date.

We consider the "survival" issues to be connected to scalability and sustainability. We all approach teaching and learning in different ways, depending on for example the situation, the subject, and/or the learners. What works well for one situation, may not work at all in another one.

Many mobile learning systems start as small-scale trials, and it is important to consider how the trial can be adjusted to include for example another group of learners, another group of teachers, or another subjects. We refer to this adjustment as scaling the system, and scalability is hence the ability to scale. It is also important that a mobile learning system supports and suits the situation it is used within. If, for example, the system fails regularly or is dependent on external resources that are not guaranteed to be available, the benefit will be reduced. We refer to such issues as sustainability issues. For example, Traxler and Leach (2006) found that the access to electricity became a problem in a trial where PDAs were deployed to teachers in rural Africa. Some of the teachers could not charge their devices regularly and found that all the data on the device was lost when it died.

Scalability concerns how well a mobile learning system can adjust to suit another context and sustainability concerns how well it works within a particular context. There is a strong relation between the two concepts, and a mobile learning system should be able to scale to the intended use and be sustainable within the setting. The two concepts are discussed in further detail by Wingkvist and Ericsson (2009a).

The focus of this paper is to investigate how to support developers to create sustainable and scalable mobile learning systems. The developers of (information) systems face similar problems and have established a set of best practices to help deal with them. By studying the development process of mobile learning, and finding similarities between it and the development process of systems, we aim to find similarities that allow us to adopt these best practices.

2. DEVELOPMENT PRACTICE AND FORMALIZATION OF MOBILE LEARNING

The idea to use information technology to support learning is not new. The term e-learning is often used to describe the use of computers in education, but the term itself is ambiguous and can refer to many different aspects of technology-supported learning. A common meaning of the term is web-based distance education. Almost all definitions have a strong focus on technology, and much of the research into the field of e-learning has focused on the development and use of information technology.

An early definition of mobile learning by Quinn (2000) referred to it as e-learning using mobile devices stating "it's e-learning through mobile computational devices: Palms, Windows CE machines, even your digital cell phone". This definition carries over the e-learning focus on technology to mobile learning, and considers it as a means to access content, rather than as a way to integrate learning as a part of an increasingly mobile style of life.

The concept of mobility in mobile learning is larger than the mobility of devices. Sharples et al. (2009) define the mobility in mobile learning as including:

- the physical space,
- technology,
- the conceptual space,
- the social space, and
- time.

Learning can (and does) happen at any time and at any place. Sometimes the location or time is important to learning (such as a museum visit) and sometimes it is just a setting (such as the gym). Research in the field of mobile learning can be considered the investigation of how these aspects of mobility assisted by technology can help learners to receive and gain new knowledge.

The new focus of mobile learning has resulted in a call for a theory of mobile learning that incorporate how mobile learning differs from other kinds of learning. Sharples et al. (2005) define five criteria and suggest that any theory of mobile learning should be tested against these questions;

- is it significantly different from current theories of class-room, workplace or lifelong learning?
- does it account for the mobility of learners?
- does it cover both formal and informal learning?
- does it theorize learning as a constructive and social process?
- does it analyze learning as a personal and situated activity mediated by technology?

A number of attempts to provide a solid theoretical basis for mobile learning have been made and the rest of this section highlights a number of the theories produced.

Sharples (2005) proposes that mobile learning is defined as "the processes of coming to know through conversations across multiple contexts amongst people and personal interactive technologies". A central claim of this statement is the importance of conversation. Sharples rest upon work by Dewey and Freire, and claim that conversation is "the driving process of learning". To better understand and define the conversations and the role they play in the process of learning, Sharples turn to Conversation Theory (Pask, 1976). Conversation theory has been used for similar purposes, for example by Laurillard (2002) and Sharples (2003). Technology provides the means for or enriches conversations. Every human involved in a conversation has a physical location, a context. This context has to be negotiated by the parties of a conversation, since mobile learning allows for the learners to experience different contexts. The learning is characterized as a process of coming to know through conversation across continually reconstructed contexts.

In order to better understand the learning activities and the context, Sharples et al. (2005) suggest to analyze mobile learning as a cultural-historical activity system (Engeström, 1987) mediated by tools. They further suggest that the expanded activity model should be viewed from two perspectives (i.e., have two layers), a technical and a semiotic, in order to better explain the role of technology in learning. Similarly, they suggest that the cultural Rules, Community, and Division of Labor should be renamed Control, Context, and Communication to better support the communication between educational researchers and technology developers.

The theory developed by Sharples et al. (2005) is used (as an input) to formulate a systems development methodology for mobile learning by Taylor et al. (2006). It is based on the socio-cognitive engineering methodology, which focus on the analysis of interactions between people and computer-based technology. Socio-cognitive engineering is user-centered but also acknowledge, "users are not always reliable informants" (Sharples et al., 2002). In order to deal with this, the methodology suggests to both carry out field studies to study users and how they interact with technology as well as to take an analytical stance and for example study the cognitive processes and social interactions to form a theory of use. These two together

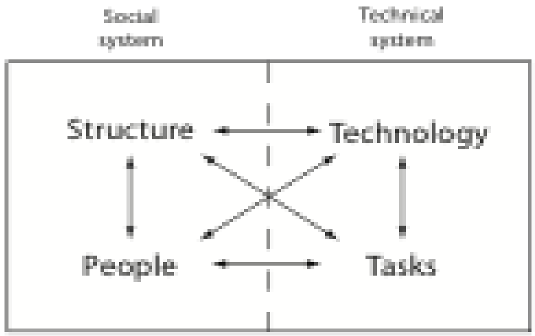

Figure 1: A Socio-Technical System

form a task model that is used as input to the iterative development practices of socio-cognitive engineering and Taylor et al. (2006) provide such a task model for mobile learning.

Taylor (2004) presents also a conceptual model where the overall aim is to evaluate the pedagogical effectiveness of mobile learning and thus ensure that it is sound. She is starting from a technical standpoint, entering into usability aspects, and continuing with pedagogic issues and socio-pedagogical perspectives while also acknowledging that these areas influencing each other. The intent is to guide evaluation to understand the reasons for success or failure respectively.

In another effort to deal with the development of mobile learning, Vavoula and Sharples (2009) propose a conceptual model built on holistic and systematic evaluation divided in three levels of granularity, i.e., micro, meso, and macro, to guide the data collection when designing, implementing, and deploying mobile learning. The requirements analysis persists throughout an initiative's life cycle, and covers all three levels of analysis. They conclude that mixed methods are increasingly present in the design of evaluation activities for mobile learning. The core approach is to continuously address the granularity and employ strategic evaluation to guide the development process.

3. A SYSTEMS VIEW OF MOBILE LEARNING

The development of systems started with a strong focus on the computer. Their development and introduction into the organization was considered a technological activity. However, the introduction of a system normally has social, organizational, and human implications and is never just a technological activity (Smithson and Hirschheim, 1998). Hence the approach to regard system in terms of a socio-technical system emerged, acknowledging it as a system that involves complex interactions between people, machines, and the work environment, according to Emery and Trist (1960). Another example, also building on the socio-technical school of thinking acknowledges these as two separate systems, the social and the technical, respectively, and focuses explicitly on the interactions between them (Bostrom and Heinen, 1977). The two dimensions, social and technical, can be divided into People and Structure, and Technology and Tasks, respectively. Figure 1 depicts this view of a socio-technical system.

While much criticism has been directed towards the socio-technical school of thinking, there is consensus that a system can be considered to have both technical and social dimensions. This is acknowledged by the systems development methodologies and methods used.

It is clear from the discussion in Section 2 that mobile learning systems have both social and technical dimensions (they do contain a system), but are those two dimensions enough? If we use the definition of a socio-technical system by Bostrom and Heinen (1977) on a mobile learning system, the learning goal would belong to the Tasks, the pedagogy would be considered Technology, and many of the stakeholders, such as learners and their parents, would be considered People. While this view is not necessarily wrong, it does not correspond well with the understanding of learning.

One major goal of mobile learning is to allow the learners to be mobile in time and space, and make the learning more personal (Kukulska-Hulme and Traxler, 2005). Learning is individual and different individuals learn in different ways. Merrill et al. (1996) state "groups don't learn, individuals learn. Learners may be part of a group while learning, learners may learn from one another, and the social context of a learning environment may provide support for its members; nevertheless the change in cognitive structure and the acquisition of knowledge and skill is an individual event". For example, some students may pick up a mathematical concept by reading about it in a book, while others may need to solve several exercises and practice different strategies to get it. Both methods will result in learning, and mobile learning should support all the learners and offer the opportunity to learn in their own way, as far as possible.

The individual and personal nature of learning is visible in a study of the development and outcomes of mobile learning initiatives. Wingkvist and Ericsson (2009c) contains examples of this, for example "student ownership and 24/7 access to a handheld device are central to the approach", and further along this line "where students had constant use of the mobile devices, there was evidence of a growing sense of autonomy, as learners created their own uses to meet personal purposes". This suggests that the students learned better when they were able to experiment on their own, in a manner that suited them.

The socio-technical system view depicted in Figure 1 does not contradict the view that learning is personal and individual, but it does not promote it either. The division

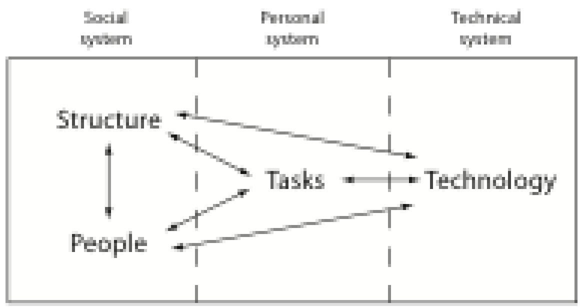

Figure 2: An Extended Socio-Technical System for Mobile Learning

into pedagogical theory as technology, the learning goal as task, and the learner as one of the stakeholders gives a fragmented view of the learning. In order to deal with this, an extended view of mobile learning is suggested that places learning into a personal system and puts the same emphasis on it as the social and technical. Figure 2 depicts this extended view.

The new extended view introduces a personal system that contains the Tasks. In this view, Tasks is synonymous with the process of learning. The Technology contains all the technology, such as mobile phones and software that support the learning. The classification of People has been changed to not include the learner, but instead refer to other people he or she interacts with, such as classmates and teachers. The extended socio-technical model acknowledges that the individual is separate from the social dimension.

4. MOBILE LEARNING DEVELOPMENT SUPPORTED BY SYSTEMS DEVELOPMENT

The previous section introduced an extended socio-technical system for mobile learning. There is a large amount of theory that is derived from the socio-technical system view. However, the main change is that the learning, i.e., the task, has moved from a technical perspective to a personal one, focusing on the individual nature of learning. This means that People, Structure, and Technology are unaffected, and hence, theory might still be applicable, at least to concerns that fall within these.

We conducted two studies to see how useful analyses based on the socio-technical system were for mobile learning. First, we performed a post-mortem *stakeholder analysis* of three mobile learning initiatives (Wingkvist and Ericsson, 2009b). User participation is key to capturing interaction between the social and technical dimensions, and if stakeholders are not identified or invited to participate, it may result in end products that are not sustainable. The second study focused on *risk analysis*, and we performed a post-mortem risk analysis on empirical data gathered from fifteen initiatives (Wingkvist and Ericsson, 2009c). The aim was to identify risks (unsatisfactory outcomes) in Technology, Social, or the interaction, that may result in an end product that is not sustainable. A failure to identify stakeholders can be considered such a risk, so the latter study is more general.

The stakeholder analysis revealed that while each initiative had a slightly different approach to stakeholders, there were many similarities. All the projects tended to treat stakeholders as a resource available when needed. For example, the technological platform was designed and decided by the members of the initiative before any stakeholders were consulted. So, when the stakeholders were finally involved, they were limited by the choices the developers made when designing the technological platform. The stakeholders were also consulted in turn, i.e., when a group was needed, they were asked and their feedback was noted/integrated. When another group was needed, they were asked. There was not a holistic view of a group of stakeholders, but rather an atomistic.

The atomistic approach resulted in mismatches, which in turn may result in sustainability issues. By inviting stakeholders to participate in the design process and thus adopting a stance towards stakeholders similar to the one advocated by socio-technical systems design, the mismatches might have been avoided, since all stakeholders would have been consulted before requirements and consequently decisions were locked down.
The risk analysis uses a socio-technical model by Lyytinen et al. (1998). The model considers risks for Technology, Task, Social, and Structure, and in the relations between these. With the application of the model a number of risks were discovered, and these found support in the results reported by the initiatives. The study found that while the model could be used, there were a number of issues involved in mapping the initiatives to it. This is supported by the discussion in the previous section, as it was problematic and unintuitive to deal with pedagogical approaches as Technology, for example. The model also felt overly complicated, and it was difficult to map risks to one out of the six possible relations (illustrated by the arrows in Figure 1). This, however, is a concern related to the model, and not due to the socio-technical view itself.

While the result of the two studies is far from conclusive, it suggests that the two analyses used could have improved the outcome of the initiatives studied. It further suggests that the theory of socio-technical systems is applicable to mobile learning. Some cases, such as the risk analysis, will benefit from being adjusted to the extended socio-technical model, but this is a straightforward practice

5. BRIDGING THEORY AND PRACTICE

In Sections 3 and 4 we provide a theoretical view of mobile learning and a set of methods that can be used within that theory. While both of these are important contributions,

Table 1: An Overview of the Development Stages

Stage	Purpose	Outcome	Key Activities
Idea	Establish soundness of the idea Establish technical platform	Plan of how to go ahead	Investigate technology Investigate feasibility Surveys
Trial	Test the idea Elaborate the learning Small scale testing	Information about what works and what does not Considerations made on what needs to change in order to move ahead	Produce learning material Offer the learning material Measure how well it is received
Project	Expand beyond initiators Large scale testing Formalized in terms of resources and outcome Establish social interplay	Information on how the material is received, both in terms of learners and teachers experience	Similar to trial but larger scale Report to funding agency
Release	Hand over to target organization Remove reliance on initiators	Implemented and in use	Integrate into the organization (training) Establish facilities (servers, studios, etc.)

neither is on a level that is suitable for practitioners within mobile learning. There is a need to bridge the two and provide a framework that captures the theory and offers a place for the tools.

Much effort has been put into systematizing the development process. One important aspect of this is the formulation of life-cycle models, for example, the Systems Development Life Cycle (SDLC) (Sommerville, 2006). Such life-cycle models describe the development of an system as a set of stages, to plan, manage, control, and evaluate the same (Avison and Fitzgerald, 2006). When observing the development of mobile learning initiatives, it was found to be highly iterative, but with well defined progressions in terms of various steps. Based on observations, four major stages can be identified namely Idea, Trial, Project, and Release. Any mobile learning initiative should progress through these. Each stage represents a specific activity and specific goals. For example, the Trial stage revolves around testing the prototypes in a controlled environment with limited groups. A stage can contain several iterative development cycles and a large number of actual trials. When a stage is considered finished, i.e., the results are satisfactory, the stage is over. It is generally difficult to go back and repeat a previous stage, so progress from one stage to another should only happen once it is "completed". The stages, with purpose, outcome and key activities are summarized in Table 1.

A sequential life cycle makes late changes costly. When summarizing lessons learned from Multiview, Avison et al. (1998), state that the sequential life cycle is inappropriate for describing the real nature development practice. However, Avison et al. (1998), also found that an iterative life cycle can be difficult to use since it lacks a well-defined progression. In order to support an iterative life cycle as well, each stage can be thought of as containing a number of iterations. The life cycle is iterative inside each stage, but sequential over the four stages specified.

The three dimensions of the extended socio-technical system for mobile learning (cf. Section 3) is present within each stage of the life cycle. To incorporate them and make the visible, each stage is divided into four Areas of Concern. The additional area is created by dividing the social system into Social (People) and Organization (Structure). The other two areas are Technology (Technology) and Learning (Tasks). Technology is the hardware and software used, Learning includes the pedagogy and teaching goals, while Social includes how learners and teachers use and interact using the technology. Organization represents the organizational concerns, for example laws and regulations, and school policy.

The Areas of Concern can be considered as views. Each area of concern deals with a specific aspect of mobile learning and can be linked to a specific group of stakeholders. Since the four Areas of Concern represents different views on the same IT artifact, they are interlinked. A change to one of the areas will affect the others. By discussing how any decision will affect the four Areas of Concern, there is a built-in analysis of how a decision affects stakeholders and what possible risks it might create.

Table 2: The Key Concepts Summarized

Stages	The development of a mobile learning initiative goes through a number of Stages. Mobile learning initiatives go through a development process that can be summarized using the following four stages: Idea, Trial, Project, and Release.
Areas of Concern	Each stage deals with a number of concerns or requirements that deal with different aspects of the mobile learning initiative. There exist an interplay of technical, pedagogical, people-related, and bureaucratically considerations and these are called, in short, the following areas of concern: Technology, Learning, Social, and Organization.
Focus	Focus is a way of reducing complexity. Each stage deals with the areas of concern, but it was found that certain areas are more prominent during certain stages. By applying focus on particular areas, these provide the primary concerns to investigate.
Equilibrium	The concept of Equilibrium is the measure of when the inner development process has reached a "final" state. When all the concerns within a stage, both those within areas in focus and those indirectly affected by the focused areas are in balance, equilibrium has been achieved.

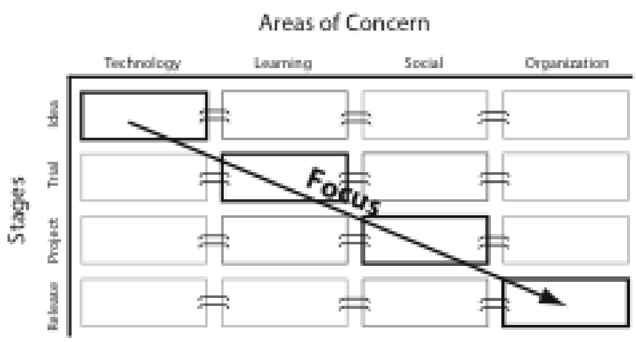

Figure 3: The Life Cycle and Areas of Concern

The Areas of Concern support the iterative development practices within a stage. Changes will propagate between the areas, and result in new changes that will propagate in turn. However, as discussed previously, there is no defined progression, and the propagating changes may make it more complex. In order to deal with this, mediation between the Areas of Concern is needed. The concept of focus is introduced in order to provide mediation and reduce complexity. This is inspired by Avison and Wood-Harper (2003) reasoning about mediation using the metaphor of a camera. Using focus it is possible to see all four areas at the same time, but only by sacrificing the level of resolution. So, it is possible to focus on and examine one particular area in great detail, but at the expense of losing some of the greater context.

The use of focus in relation to the Areas of Concern provides a sequential progression. Each area of concern is focused on in turn, and the main development objectives revolve around that area. Changes to one area will still affect the others and need to be managed, however, by only focusing on one area — one potential source of change — a sequential progression is maintained and complexity is reduced.

In order to deal with the interlinked Areas of Concern and the propagating effects that a suggested change will have, the notion of equilibrium is introduced. This is similar to Leavitt's model for organizational change (Leavitt, 1965) where the term equilibrium is used to signify that the opposing forces of a change are in a steady state, i.e., the effects of the change have been compensated for. The term is used in a similar manner here, where it signifies that a change has propagated to all related Areas of Concern and that each area has been adjusted to deal with the change. To continue the example with video podcasts, any stage where the effects of introducing video to one or more areas are ignored will not be in equilibrium. A system that is not in equilibrium will contain risks not assessed that might result in a failure to obtain any or all of the benefits of the IT artifact at a later stage. Since there might be risks not considered in a stage that is not in equilibrium, it is not possible to progress to the next stage before equilibrium is reached.

The stages and the Areas of Concern together form the framework. The concepts of Focus and Equilibrium are there to support the practitioners that use the framework. Focus helps to create a sequential process, while Equilibrium is a means to know when to move to the next stage. Figure 3 depicts the framework and the major concepts are summarized in Table 2.

The framework is a way to bridge the extended socio-technical system and development practice. In this sense, the framework is similar to a systems development methodology (Hirschheim et al., 1995). It is backed by a philosophy, the extended socio-technical system, and offers a collection of methods that help the system developers in their efforts. The goal of the framework is not dictate how to development mobile learning systems, but rather to act as a guide and offer helpful advice. We agree with Avison et al. (1998) in that a large number of stages, methods, and tools might make a methodology a blunt instrument that is difficult to master. Avison and Fitzgerald (2006) state that a framework is similar to a methodology but less restricted and rather than enforcing a strict step-by-step order it leaves room to choose what best suit the situations, people, or organizations. A framework can provide the overarching structure of the development practices and be a platform for work and communication. This is the reason we present a framework rather than a methodology.

6. DISCUSSION

We began by establishing the premise that scalability and sustainability is key to increasing the "survival rate" of mobile learning initiatives. The two are linked, and both are necessary. Scalability relates to how well an initiative can grow and adapt to changes. Learning and teaching depend on the people, the subject area and the setting. One teacher may approach a certain subject in one way, while another use a completely different strategy. This makes it difficult to create top-down learning efforts. There are often policy documents that regulate the teaching, but how the content of those documents is set into practice is developed bottom-up. In mobile learning, this is visible by the reliance on small-scale trials. Ideas and concepts are tested in a subject, in a setting or in a class, in order to depend on fewer variables. Scalability comes into play when a trial is successful, since that is when it is time to expand the trial and consider expanding one or more variables, for example by including two subjects. There should be a plan for how to achieve this, what needs to change, an so on. This is scalability.

Sustainability can be considered a measure of whether a trial is successful or not. An important part of sustainability is that the end result should work without active "assistance". If there is a need to constantly tweak or fix the mobile learning system, it is not sustainable. If it cannot work in the environment, it is not sustainable. For example, returning to the trial in rural Africa who offered PDAs to help teachers. However, the PDAs needed to be charged at regular intervals or they would lose everything stored on them. Traxler and Leach (2006) reported that some of the teachers did not have regular access to electricity, and ended up losing large parts of their work. This is not sustainable.

In order for the framework to help increase the "survival rate", sustainability and scalability needs to be incorporated in the core of project management. The framework should clearly capture the processes and help developers reason about them. Scalability happens between the stages of the life cycle. When an initiative has reached equilibrium at one stage, it needs to grow to the next stage. There is a need to plan how to progress, how each of the four Areas of Concern needs to change, and how the changes will affect the other areas. A large part of scalability is to limit the scope of the change, i.e., to minimize the ripple effects. Scalability means the ability to extend the results from the previous stage and combine them with knowledge of the Areas of Concern of the next stage.

Sustainability is closely related to equilibrium, and during intermediate stages, the sustainability and equilibrium can be considered the same. Equilibrium is a steady state, where a stage is working according to some pre-determined, "final" specification. The major difference between the two is that equilibrium happens at least once within each stage, while sustainability is a property of the entire initiative. Reaching equilibrium in the trial stage is not enough for the full initiative to be sustainable; it just means that it is sustainable at this point in time. An initiative that has reached a stage with realistic and "final" concerns and reached equilibrium at this stage is considered sustainable.

7. CONCLUSIONS

In this paper we investigate how to approach mobile learning and model it using an extended socio-technical system. The major change to the traditional socio-technical system is that a personal dimension has been added, and the Task has been moved from the technical dimension to the personal. This change is intended to reflect the personal nature of learning. It also addresses a concern regarding the organizational bias of the traditional socio-technical view.

New theoretical contributions, such as the extended socio-technical system for mobile learning, are more aimed at the research community of mobile learning. The main consumers of such a result would be the researchers working towards conceptual modeling, such as the ones discussed in Section 2, seeking theoretical foundations and communication platforms for their work. To address practitioners, we instead present a framework that builds upon the extended socio-technical system. A framework can provide the overarching structure of the development practices and be a platform for work and communication.

We identify the two major issues that affect the "survival rate" of mobile learning initiatives as scalability and sustainability. The framework presented in this paper integrates these concepts, and makes them easy to reason about, communicate and deal with.

A next step in the coming research would be to provide the framework to a number of initiatives in order to study how they use it and what feedback they can offer. This should be followed by a more extensive study where the effects of using the framework are investigated. For example, one possible way could be by having several teams working on similar efforts and having some of them using the framework and others not. By closely observing the development processes of all the teams as well as the outcomes, further insights into the applicability of the framework can be gained.

The framework presented in this paper could be offered to funding agencies to serve as an aid to help decide what to fund and when to evaluate. The framework could, for example, serve as an indicator as to when the evaluation of a funded mobile learning initiative should take place. The division of the life cycle of an initiative into four distinct stages could help to decide which initiatives to continue to fund. An initiative that successful reaches equilibrium at for example the Idea and Trial stages might prove more sustainable and a better candidate for funding than one that has yet to start the Idea stage.

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Unearthing Invisible Buildings: Device Focus and Device Sharing in a Collaborative Mobile Learning Activity

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Abstract

Recent research has identified excessive focus on the mobile device itself as a serious problem in mobile learning. Various recommendations have been formulated for the design of mobile learning technology and pedagogy to reduce device focus and foster students' engagement with peers and with their environment. This paper describes how some of these recommendations have been implemented and extended in the design of *Invisible Buildings*, a mobile collaborative game-based activity for schoolchildren. It reports the results of an empirical evaluation of the learning experience with primary school children, focusing on students' engagement with their social and physical context during learning activities, and providing insights into their behaviour and strategies with respect to device sharing.

Keywords

Mobile Learning, Device Focus, Device Sharing.

1. INTRODUCTION

Over the last decade our understanding of mobile learning has shifted focus from mobile devices and technologies to learner mobility and the social practice it enables. A key concept in this new understanding is *context,* created by the learner in interaction with others, with their surroundings and with the tools they use (Kukulska-Hume et al., 2009). Recent research, however, has pointed out that in many mobile learning projects where students share a mobile device to complete tasks collaboratively, their engagement with the environment and with each other is reduced significantly as they focus too much on the shared mobile device (Eliasson et al., 2010; Göth et al., 2006).

To address this problem, a number of design guidelines for mobile learning technology and pedagogy have been proposed. In HCI, where device focus and related issues in mobile computing have been researched for some time, efforts are generally aimed at reducing the cognitive load for users when interacting with the device, for instance by simplifying interaction screens (e.g. Pascoe et al., 2000) or balancing visual interaction with haptic or auditory feedback (e.g. Brewster, 2002). More holistically, Göth et al. (2006) advocate a *mobile phone* metaphor (as opposed to a *small screen* metaphor) for the design of mobile applications, which takes into account the specific use context, hardware characteristics and network requirements of mobile devices. From a pedagogical perspective, recommendations include assigning learners dedicated roles that require negotiation and coordination in collaborative learning situations, conceptualising mobile devices as tools that support learners in completing activities (as opposed to controlling and structuring the activity) and integrating teachers and support staff into mobile activities to scaffold learning and keep learners focused on the task (Eliasson et al., 2010).

The following sections describe how device focus and the related issue of device sharing were addressed in a collaborative mobile learning activity known as *Invisible Buildings*. We explain how some of the recommendations in Eliasson et al. (2010) were implemented and further extended, report on the empirical evaluation of these measures and conclude with a discussion of the findings.

2. INVISIBLE BUILDINGS

Invisible Buildings is a cross-curricular whole-day learning experience integrating outdoor mobile location-based games with complementary indoor classroom-based activities for primary school children aged 9-10 years. The learning experience is based on the discovery and excavation of an imagined Roman Villa beneath the school grounds and links to a wide range of curriculum subjects.

The learning experience uses custom-made mock-up tools derived from authentic archaeological practice, with integrated GPS-enabled smartphones used to discover and excavate virtual objects, together with a related project website that shows these objects as they are "found" in the school grounds and holds additional resources with background information relating to the objects and the wider project for indoor activities. The children's activities are coordinated and motivated by a professional actor presenting himself to students as an archaeologist,

The project is structured into three outdoor activities in which students collaborate in teams to uncover virtual objects and structures in the school grounds, and alternating indoor activities where pupils reflect on their outdoor experience, discuss the meaning and implications of found objects and prepare their next steps outdoors.

Together, these activities form a chain of discovery, reasoning and further action (Figure 1) that ultimately leads them to uncover a virtual Roman Villa beneath their school grounds, a model of which they can then explore in the concluding indoor activity.

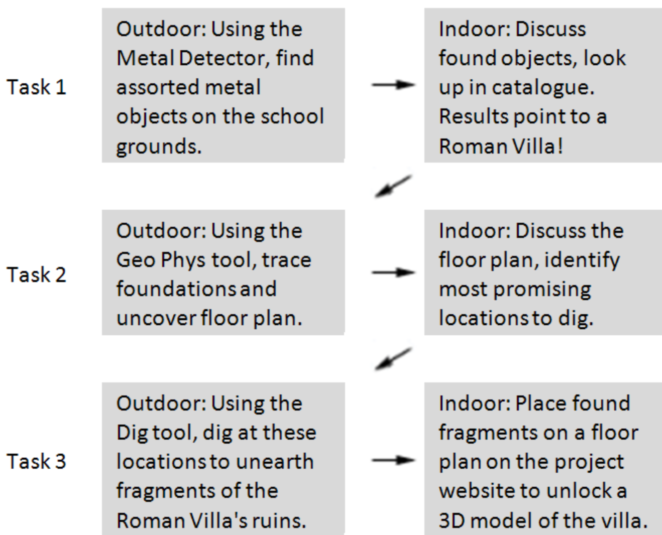

Figure 1: Chain of activities and reasoning leading to the discovery of a Roman Villa beneath the school grounds

In order to keep group sizes manageable and optimise use of the available equipment, classes are divided into two halves which alternate in completing outside / inside tasks. For outdoor activities, each group is then further divided into teams of four pupils each, who stay together for the whole day and collaborate in each learning activity.

3. DESIGN ASPECTS

3.1 Dedicated roles

Eliasson et al. (2010) suggest using two or more mobile devices with different roles in a team, which implicitly assigns different roles to the students using them. *Invisible Buildings* uses only one mobile device per team. However, it defines dedicated roles for team members in each task, which are explained to students in detail before they begin their outdoor activity (Table 1).

Table 1. Roles in each team for the different tasks

Task 1: Metal Detector	
Controller	Control the tool, interact with mobile device
Stopwatch	Measure time
Hooter	Alert archaeologist when objects are found
Notes	Take notes, make drawings of found objects
Task 2: Geo Phys	
Controller	Control the tool, interact with mobile device
Cones	Put down cones to mark outlines of floor plan
Hooter	Alert archaeologist when wall / line is found
Notes	Take notes, make drawing of floor plan
Task 3: Dig	
Controller	Control the tool, interact with mobile device
Helper	Secure boring head in position (inside cone)
Helper	Push digger lever
Helper	Push digger lever

In order to give each team member an opportunity to control the main tool for the task and interact with the integrated smartphone, roles are swapped after a certain time when the archaeologist gives the agreed signal.

Auxiliary tools were introduced for each supporting role to emancipate team members in relation to the main tool controller and accentuate their specific purpose in the task. These tools included an electronic stopwatch to measure time, a hooter to notify the archaeologist when objects were found, a set of plastic cones to mark the outlines of the Roman Villa and a notepad to take notes and make drawings of found objects (Figure 2).

Figure 2: Auxiliary tools for supporting roles: hooter and clipboard for note-taking

Based on research into conflicts and competition between children over shared resources in co-located collaboration around a tabletop (Marshall et al., 2009), it was hoped that these auxiliary tools would reduce interference from students in supporting roles with the device controller, as they add weight to their roles and encourage independence.

3.2 Mobile devices as tools

In order to avoid students being pushed into a passive role by mobile applications that structure and control the flow of learning activities, Eliasson et al. (2010) suggest approaching mobile devices as tools and utilising their inbuilt sensors to complete activities. This idea was further extended in *Invisible Buildings* by integrating the smartphones into mock-ups of tools used in authentic archaeological excavations, including a metal detector, geo-physical H-frame, and a digging instrument.

It was hoped that the integration of smartphones into mock-up tools would emphasise their specific purpose in each learning activity and create a more "life-like gaming experience" (Burrill, 2010). This approach is onceptually similar to commercial products like Mobile Art Lab's PhoneBook (PhoneBook, 2010), which embeds a smartphone into a physical children's book and thereby reduces the mobile device to an interactive image in the book that changes content when pages are turned, and to game peripherals for the Wii controller (Figure 3), which turn the controller into a physical tool with similar ergonomic qualities to the real-world tool they represent.

Figure 3: Wii steering wheel with embedded controller

Figure 4: Mock-up metal detector composed of lightweight waste pipes. The smartphone is embedded into an open box attached to the tool handle (circled)

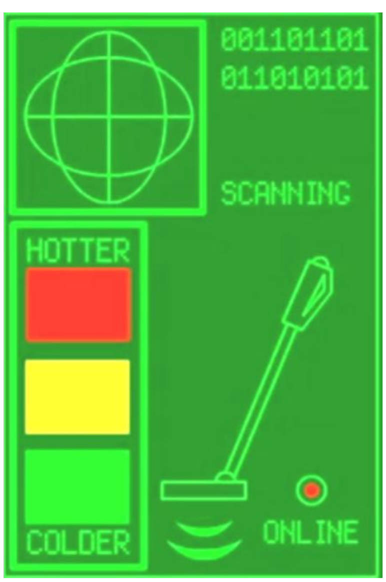

Figure 5: Metal detector application running on the mobile device embedded into the Metal detector tool

In order to make them reusable and light enough for children to carry, the tools were composed of standard lightweight plastic waste pipes, bends and couplings that could easily be re-configured into the next tool in-between the learning activities. The smartphones were strapped into a small open plastic box fixed to the tool handle in order to protect the device and reduce daylight glare (Figure 4).

The mobile devices ran different applications for each outdoor task. The applications used the smartphone's inbuilt GPS receiver and network capabilities, and provided a task-specific touch-screen interface designed to look like an authentic tool (Figure 5). These measures reduced the smartphone to a mere user interface for the mock-up tool and helped to further enhance the tool's credibility.

3.3 Integrate teachers and support staff

Eliasson et al. (2010) point out that the involvement of teachers and technology personnel in mobile learning activities can scaffold students' learning and help to keep them focused on the task instead of the device. Taking this into account, all adults involved in *Invisible Buildings* played a role in the project and a professional actor was introduced to play the part of an Indiana Jones-style archaeologist. Teachers were responsible for logistical issues (e.g. dividing classes, forming teams, etc.) and in addition provided technical and subject related support. Technical personnel and research staff provided technical support and helped to keep students on task through guidance and encouragement. The archaeologist directed operations (constructing the narrative, introducing activities, explaining tools) and was the main contact for students to discuss subject issues.

3.4 Encouraging face-to-face collaboration

Instead of building collaboration directly into the mobile application and thereby forcing students to collaborate through the device, Eliasson et al. (2010) recommend placing collaboration outside the mobile device: this can increase face-to-face discussions between students and thereby support learning. This point was addressed in the project by using the mobile devices as tools only and leaving it to teachers and the archaeologist to structure and control the learning experience. Face-to-face collaboration between students was expected when students negotiated directions and locations to probe and when they discussed the meaning of found objects. Indoors, teacher-led discussions enabled students to reflect collaboratively on their outdoor experiences.

4. EVALUATION

Invisible Buildings was evaluated over two consecutive days with two mixed gender classes of primary school children aged 9 to 10 years. Overall, 53 children took part in the study. The data analysis and evaluation were carried out by usability experts from the Interactive Technologies Research Group at the University of Brighton.

4.1 Ethical Considerations

With respect to the involvement of underage volunteers in the study, ethical issues were considered before and throughout the evaluation. Based on Anderson's (1990) guidelines regarding volunteers in research projects and Burgess' (1989) discussion of ethics in educational research, specific considerations included collecting data anonymously and not making it available to third parties, informing pupils and their parents about the context and purpose of the study and pointing out to them that they could withdraw at any time without giving a reason. A consent form was distributed before the event, and pupils and their parents had an opportunity to discuss details with the supervising teacher.

4.2 Data Collection

4.2.1 First-person video observation

In order to record interactions from the user's point of view and obtain a contextualised view of the device screen, the device controller in a selected team of students wore a head-mounted camera fixed on a baseball cap, together with a microphone attached to his/her outer clothing and a carrier belt holding a miniature video recorder and energy supply. As pupils swapped their roles to allow everyone a chance to interact with the smartphone and mock-up tool, the camera cap, microphone and belt were transferred to the next student with the help of a researcher, so that the head-mounted camera always had a direct view on the mobile device and would record all user interactions.

4.2.2 Third-person video observation

To complement the head-mounted camera view, one researcher accompanied the same group of pupils with a handheld video camera to record video material from a third-person perspective. In addition to documenting whole-group interaction and interaction between groups, the material gave a useful second perspective on critical situations, which helped researchers during the analysis to better understand these situations as a whole. Indoor activities were recorded with a static camera placed in the classroom.

4.2.3 Questionnaires

A questionnaire was administered after each outdoor task when pupils returned to the classroom, to collect immediate feedback on the learning activity. The questionnaire included a closed multiple choice rating relating to the outdoor activity with categories, terminology and pictograms derived from the Problem Identification Picture Cards (PIPC) developed specifically for usability evaluations with children (Barendregt et al., 2008). In addition, the questionnaire had space for open comments where pupils could qualify their choices and give further feedback.

4.3 Data Analysis

The video material was evaluated by a panel of three usability experts from the University of Brighton. The panel watched the recorded video material for each activity, and critical scenes were repeatedly reviewed as required to better understand the issues at hand. Notes were taken during the screening and compared and discussed after each session. While the video analysis employed an emergent coding scheme and had no pre-defined themes to look out for, the experts were particularly interested in aspects of device focus, device sharing and collaboration between team members as well as ergonomy and usability problems with the equipment and mobile devices.

The questionnaire analysis involved aggregating the PIPC rating (Barendregt et al., 2008) for each activity and interpreting any trends in the data. The many open comments from pupils were analysed in a two-step emergent coding process involving first data reduction and then data visualisation to identify common themes, as described in Miles and Huberman (1994).

4.4 Findings

4.4.1 Device Focus

The video analysis suggests that the assignment of specific roles in each task and the introduction of auxiliary tools supporting these roles can help divert pupils' focus away from the mobile device and towards their environment, team members and the current task at hand. Students were often seen standing or walking in a group to complete their role-specific tasks with only the device controller observing the mobile screen while students in supporting roles focused on their own auxiliary tools (Figure 6).

Figure 6: Roles and tools - left to right: Stopwatch, Metal detector (with integrated smartphone), Notes and Hooter

For the note-taking role in particular, which required prolonged interaction to make drawings of found objects, it was observed several times that the note-taker let the team move on while finishing a drawing before catching up, suggesting that the role and auxiliary tool fostered independence while working towards a common goal.

With respect to conceptualising smartphones as tools and integrating them into mock-ups of authentic archaeological equipment, it was observed that while the children tried to get a look at the device screen in key situations, e.g. when a virtual object was found, they usually focused on their own task and only helped to carry and operate the mock-up tool as required in Tasks 2 and 3 (Figure 7). Interestingly, students were clearly aware of the embedded smartphone but willingly accepted the mock-ups as functional tools, which was illustrated by the fact that they called them by their tool name ("Metal detector", "GeoFizz", "Digger") in normal operation but used phrases like "The mobile phone is broken" when there was a problem with the application.

Without any collaborative features or control functionality integrated into the mobile applications, the video material shows much face-to-face collaboration where students communicate with team members to coordinate their actions, discuss the line of action (e.g. in which direction to move while scanning the ground for virtual objects or structures), talk about found objects and their meaning or just express their excitement and enthusiasm. Students were also observed to engage with their physical environment, for example pointing out terrain features like small hills or dips and speculating whether these would be promising areas to scan with their equipment. In addition, there was regular communication with the teacher and archaeologist, who helped to structure and control the activities by prompting tool swaps between students and telling them when to finish and return their tools.

Figure 7: Team members helping the device controller (wearing a black baseball cap) to carry the mock-up tool

The involvement of the archaeologist, teachers and technical personnel into the learning activity seemed to be a critical aspect of the project. It was observed that alerting one of the involved adults, preferably the archaeologist, on each find and receiving affirmation and expert advice as to the found object's relevance and meaning seemed very important to pupils. Some pupils went to great lengths to attract the attention of the archaeologist when something was found, by calling and using the hooter provided for a long time, before either succeeding or eventually moving on without a consultation.

In the last outdoor activity (Task 3: Dig), where no virtual objects or structures were to be found, as students virtually "dug" at previously marked locations, and where consequently the teams had no regular and formalised consultations with the archaeologist or one of the present teachers or tech personnel, students were often observed to adopt a more playful attitude and to handle the equipment with less care. For instance, both cases where the mock-up tool disintegrated during use were observed in the third task involving teams on their own while the adults were busy with other teams.

Overall, the video analysis clearly shows that the involvement of the archaeologist, teachers and tech personnel into the activities motivated students, helped to scaffold their learning and encouraged them to stay focused on the task. In addition, it ensured prompt support when equipment broke or malfunctioned, deflecting attention from technical problems and helping students to engage with subject-related problems.

4.4.2 Device Sharing

Despite the mitigating effects of roles and auxiliary tools on device focus, children were still observed in some cases to gather around the mobile device like "bees around the hive" (Morrison et al., 2009; Eliasson et al., 2010), especially when no immediate action was required from students in supporting roles and the task at hand depended heavily on visual feedback on the mobile screen.

Figure 8: Team members pointing at the device screen

While in these situations some team members continued to respect the main tool controller's right to interact with the device and only pointed their fingers at the screen (Figure 8), students used a range of strategies to gain or defend control of the device, including grabbing the tool, pushing one's own hand towards the device (Figure 9), blocking the hands of others and pushing others' hands away from the tool (Figure 10). Children were also observed to exercise control by proxy, e.g. by resting a hand, often for extended periods, on the arm of the device controller (Figure 11), by tugging and/or pushing the controlling pupil or by putting one or more hands on other parts of the mock-up tool further away from where the mobile device was encased.

Figure 9: Team member pushing hand towards the device

Figure 10: Device controller removing team member's hand

Figure 11: Control by proxy - team member resting hand on device controller's arm for extended period

In some cases a communal control phenomenon was observed where four children locked shoulders or otherwise held each other tightly, and, looking down towards the embedded smartphone and/or the ground, moved as a single unit in small tentative steps, without it being obvious how decisions on direction and or speed were formed.

4.4.3 Tool and Device Usability

Some children were observed to indicate through gestures and verbal references that the mock-up tools were heavy to carry over longer periods, which was also mentioned twice in questionnaire comments. However, these were isolated instances and overall the children seemed to have no serious problems handling the tools.

In terms of tool robustness, it was observed several times that the tool handle was not stiff enough and started bending under the weight of the rest of the tool (Metal Detector), that parts of the tool came off (Metal detector, Digger) and in two cases that the whole tool disintegrated (Digger) during use. However, these problems did not seem to suspend children's willing belief in the functionality and purpose of the tool, nor did they affect their resolve to complete the task at hand. Furthermore, in almost all instances these problems were promptly and easily fixed by the numerous helpers in attendance, without jeopardizing task completion or resulting in reprimands over pupils' sometimes rough handling of the equipment.

With respect to screen glare, the dark box in which the mobile devices were embedded to minimise glare problems did not fulfil its purpose. Children were often observed having difficulties reading the screen and trying to shield the device with cupped hands. The first-person video material confirms this problem, as the device screen is often difficult to recognise due to reflections.

5. CONCLUSIONS

Responding to recent research pointing out device focus as a “massive problem” (Göth et al., 2006) in mobile learning that is “seldom questioned or understood as a main research problem” (Eliasson et al, 2010), this paper has described how device focus and related issues like device sharing in collaborative mobile learning situations have been addressed in the *Invisible Buildings* project. Drawing on a set of recommendations formulated in Eliasson et al. (2010), which approach the problem of device focus on a conceptual and pedagogical level, the learning experience implemented measures that aimed to support face-to-face collaboration between students and divert focus away from the mobile device towards the learners' physical and social context.

These measures included:

- assigning students specific roles in outdoor activities and accentuating each role's importance and purpose in collaborative tasks with auxiliary tools
- using smartphones as a set of tools for completing tasks instead of instruments for structuring and controlling tasks
- embedding smartphones into large mock-up tools derived from authentic archaeological practice to

emphasise their task-specific purpose and heighten the game experience for students

- promoting face-to-face collaboration through a requirement for team interaction and teacher-led group discussions instead of embedding collaborative features into the mobile applications and finally
- integrating teachers and tech personnel into the learning activities to scaffold learning and keep students focused on the task.

The empirical evaluation of the project with two classes of primary school children suggests that these measures helped to mitigate device focus. While the study was not comparative and only evaluated the condition described here, it established that device focus was not a big problem in the project and that overall students showed a good degree of context awareness and independence while working towards a common goal. They understood and fulfilled their roles in collaborative activities, made use of the mock-up tools and auxiliary tools to complete tasks, communicated with team members in both task-related and social modes and engaged with the archaeologist, teachers and tech personnel to discuss the meaning of found objects and their wider implications in the context of the project.

In addition to evaluating the mobile learning experience with respect to device focus, the paper also took a closer look at the related problem of device sharing in collaborative mobile learning situations. While the measures mitigating device focus also reduced the need for device sharing, a range of behaviours and strategies employed by pupils to gain or defend device control were observed in key situations where all team members pushed towards the mobile device. Although these were less complex than children's conflicts and competition over shared resources around a tabletop (Marshall et al., 2009), there seem to be interesting similarities that transcend technological context and point towards non-technical approaches in the learning experience design.

While the large number of adults involved in delivering, supervising and monitoring the learning experience was a design decision consistent with Eliasson et al's (2010) recommendations and proved to be very effective in keeping students focused on the task at hand, it also is a weakness in the overall evaluation of the learning experience: such a high adult-pupil ratio can potentially impact on validity due to the Hawthorn Effect (Turnock and Gibson, 2001) or "good bunny effect" (Robson, 2002), where the knowledge of being part of a research study and the presence of persons of authority can have a significant impact on the behaviour of participants. This is however an integral problem of most field experiments involving novel technologies with unreliable equipment, as they require the presence of developers for ad-hoc technical support and of researchers to collect data.

In summary, the experiences in the *Invisible Buildings* project seem to support the design recommendations in Eliasson et al. (2010) with respect to device focus in mobile learning and suggest they are equally applicable to the related problem of device sharing. Embedding smartphones into mock-up tools to heighten the experience and to emphasise their role as tools, and introducing auxiliary tools that accentuate and support students' roles in collaborative tasks, extended these recommendations conceptually and physically. These measures were well received by students who willingly accepted the mock-ups as functional tools and made use of auxiliary tools in supporting roles.

While the large number of adults involved in the learning experience can be seen as a methodological weakness, it was an integral part of the approach evaluated in this study and in a wider context must be recognised as a common problem in the empirical evaluation of novel technologies.

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The impact of hand held mobile technologies upon children's motivation and learning.

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ABSTRACT
Previous work has qualitatively investigated the importance of hands-on learning using mobile technologies in children's scientific investigation. Many studies report 'improvements' when learning is 'hands on' but are these improvements measurable learning gains or an increase in motivation alone? We examined the effects of hands-on activity on both motivation and learning. Forty-six school students took part in a study which explored whether children's understanding of self-collected data differed from that of data collected by peers or teachers, and if levels of understanding of graphed data differed when the graphs were hand-drawn, hand-annotated or computer-generated. Results revealed that hands-on learning effects were limited and very specific to interpretation of graphs. However while self-collection did not seem to affect understanding, it did positively affect motivation. We discuss the relationship between student learning and motivation.

Author Keywords
Children, experiment, hands-on learning, graphs, data-logging, motivation.

1. INTRODUCTION
The use of technology can enhance a hands-on approach to learning. Advances in sensor hardware and mobile technologies, the easy transfer of data into graphs, and the ability to juxtapose this data onto locations using applications such as Google Maps and Google Earth all have the potential to create new opportunities for school science and cross-curricular learning. However, taking advantage of these new opportunities for the purpose of education requires significant work beyond technical development including: engaging teachers; understanding the pedagogical implications of the use of new designs; and engaging companies in design partnerships in order to make the resulting hardware and software appropriate for schools. It also requires the school management to be willing and able to support developments, for instance the ability to add new software to the school network, and allowing teachers time to gain understanding of the technologies. It is therefore important to understand just what aspects of these technologies may be beneficial to children's learning.
Hands-on learning with mobile technology is often advocated as the way forward in engaging children in science, by enabling them to carry out their own studies of the real world, making scientific data less abstract and more meaningful to them personally, supporting the understanding of the scientific process, as well as the results [Pea (2002); Resnick et al (2000); Rogers et al (2004); Stanton et al (2003); (2005)]. However the majority of this work has been qualitative in nature and, while it has established positive effects of hands-on investigation, it is often not so clear where the advantage actually lies. The elusive causes of 'hands-on learning' benefits are partly due to the varied use of the term to mean for example, self-collection of data, carrying out experiments in the laboratory, or even group work.
In this paper we report work which contributes to understanding the origin of hands-on learning benefits. The two aspects we are specifically concerned with are 1) *self-collection of data* – collecting one's data in the real world and 2) *'working up' or transforming these data* oneself to convey the process of translating from raw data to (scientific) concept. An experimental design reveals some of the subtleties at play in these activities. We explore issues such as: Does carrying out an investigation in the real world enhance motivation and learning? Does 'doing it yourself' - drawing your own graph in this case - give you a better conceptual grasp of such behaviours as interpreting the graph or plotting new graphs or do you gain more from using software to produce graphs, or interpreting the pre-produced input of others?
Previous studies informed hypotheses around self-collection of data, and hand-producing data. We expected: motivation and understanding to improve for data which is self-collected; ability to answer questions on graphs to improve at post-test when students generated graphs themselves; and pre-generated graphs to be better understood if students took the recordings themselves.
Our results have implications for technology designers, particularly highlighting that some qualitative work may be misleading designers on important questions such as when in the educational process automation is best used.

1.1 Background
The idea that hands-on learning is beneficial is not new. Dewey (1964) advocates that science is best understood through carrying out one's own inquiry and experiencing scientific phenomena and processes. This is supported by more recent work emphasing the importance of personal

experience for natural learning (Zoldosova and Prokop, 2006). Authentic work is important, students need to be able to relate to their work (Krajcik et al, 1998) and where possible experience the situation first hand (Johnson et al 1997). Taking part in real world studies of science is considered crucial to students' understanding, the personal involvement in investigation enabling students some autonomy and experience of the process (Resnick et al 2000). Such learning experiences are considered fundamental to understanding the basic representations and concepts that enable students to develop a more complex understanding of the world (Millar and Osborne 1998).

Emerging 'pervasive' technologies such as mobile devices, sensors, and interactive systems have the potential to enhance learning and motivation by enabling innovative hands-on learning opportunities. However, while the use of sensors in science learning is clearly on the curriculum, actual use of the equipment in schools has been limited due to problems with the usability of the technology, time and effort of setup and the complexity of importing data into relevant formats, all these interfering with the rhythm and quality of the learning process (Woodgate and Stanton Fraser, 2005; 2006)

In a study of how 13-year-olds carry out scientific investigations in the classroom, Krajcik et al (1998) found that the children did not choose to use the data they had collected to create graphs, even though it would help them to draw conclusions. Fishman et al (2001) point to the importance of building engaging and motivating small-scale projects which mirror the complexity of science and also reflect larger issues. In this respect, many argue that technology in schools is not being used to promote critical thinking. The Participate project (Woodgate et al 2009) applied both bespoke educational sensors and Bluetooth enabled mobile phones in order to capture data. Once back in the classroom, children explored and analysed their data using graphical representations over Google Earth or Google Maps to view the readings juxtaposed upon the actual locations visited. Images could also be attached to relevant parts of the graph/location as contextual cues. The authors noted that the 'seamlessness' of the experience did not always lead to fruitful discussion, and requiring children to put graphs, contextual data and location together led to more reflection upon the experience and the data itself. When graphs were automatically produced there was little discussion and a short reflection period. In comparison, when there were break downs in the automation of the experience, this initiated additional group discussion and reflection. In addition to considering seamfullness, in their 2008 report on the Participate project, Woodgate et al reflect upon the importance of students obtaining context for their data, positing that by allowing students to collect their own data and gain understanding of the data environment the student will find this a more engaging method of learning.

Others have reported inconclusive effects on students' cognitive achievements following hands-on activities, but state that they promote a more positive attitude towards science. Salmi (2003) indicated that visiting a science centre increased students' intrinsic motivation. Some would argue that promoting positive attitudes towards learning is in itself a crucial educational outcome (Mee, 2002). An educational policy report states that use of ICT across the curriculum can increase students' confidence and motivation in learning (Osborne and Hennessy 2003).

In this paper, we also explore aspects of hands-on learning that involve carrying out work yourself – in this case either drawing your own graph, using software to create graphs or annotating graphs already created for you. Barton (1998) highlights a number of problems with traditional practical work including: student difficulties linking their practical experience with abstract concepts, especially because the time taken to collect and process data leaves very limited time to 'relate the practical to the theory'; and that "information clutter", including equipment used, measurements, calculations, graphs and the problems associated with these distract students from the task at hand.

While the literature provides no evidence that students are at a disadvantage when drawing graphs manually there are a number of studies suggesting data logging could aid the process. The following advantages have been found for data logging over manual collection and recording of results: Friedler and McFarlane (1997) found evidence that for some age groups data logging over traditional apparatus leads to improvement in children's ability to read, interpret and sketch line graphs. Barton (1998: 366) found that the real-time production of computer graphs enabled younger, weaker students to explain, make predictions and make links to previous relevant knowledge, stating "manual graph plotting should be avoided when the main aim is to interpret relationships via graphical analysis". Choo (2005) states that presenting a number of graphs simultaneously or one at a time representing the same data in different ways can aid pupil's conceptual understanding. Recent work (Baggot et al, 2007) has indicated that students and teachers alike feel that instant graphing software can reduce drudgery. It was also noted that visualisation can be important for understanding, with teachers reporting that the use of simulations being highly motivating for the students. These two ideas underlie our experiment design whereby we were keen to understand whether context and an ability to visualise the situation led to greater understanding of data, while simultaneously comparing instantaneous graph-drawing software with more traditional hand-drawn annotation methods.

In order to explore these findings further we developed an in-depth investigation which manipulated the level of interaction required to maintain the benefits of data loggers while also ensuring students understand the data transformation process. The experiment compared multiple levels of data collection (self, peer, pre-collected) and different methods of presenting the data (pre-presented, software-presented and hand-drawn). We set the study up to be as ecologically valid as possible, with children working in pairs and groups to collect and discuss data, but assessment was carried out on an individual basis.

2. HYPOTHESES

We wish to explore whether technologies that support shared exploration of the scientific data space around them can also measurably enhance children's engagement in more directed pedagogical situations. From the above literature, we hypothesise that:

1. Motivation will improve for data acquired in context (self-collected)
2. Understanding will improve for data acquired in context (self-collected)
3. Pre-generated graphs will be better understood if students acquired the data themselves.

3. METHOD

3.1 Participants

A total of 46 students from 3 schools took part in the experiment, with a range of ability represented. Eight sets of data were discounted for statistical analysis purposes due to one child having learning difficulties and seven discontinuities within the groupings - some classes arrived with extra students which meant that a few students needed to work in larger groups than required for the experiment. The students ranged in age from 12 to 14, with 14 girls and 24 boys participating.

Half of the students had a 'hands-on' experience of using mobile sound data loggers (which measured and recorded sound in decibels) at a location, while the other half were shown the potential use of a data logger but did not personally use it.

14 students used computer software to generate graphs, 12 students were asked to annotate pre-produced graphs and 12 students were given data tables to display in line graph format by hand.

Each student finished with two graphs, one of Location A (either they or their partner had visited this site) and one of Location B (data collected by the researcher from a location not visited by the students). In addition, each student completed three booklets: a pre-test, a workbook, and a post-test.

2.2 Design

The design was a 2x3 between subjects design, the independent variables were Collection method (Self-Collected or Peer-Collected) and Production method (Software-Produced, Manually-Produced or Pre-Produced). Students experienced different methods of data collection and data presentation dependent upon which group they were in.

Sound was used in the experiment as it was a concept students of this age are already familiar with. It can be easily recorded, and most importantly students who experienced the locations can make connections between the sounds they hear and the graphical recordings that they take.

The pre- and post-test booklets were counterbalanced to ensure that they did not differ in difficulty. Of the students who went out to collect data, students were counterbalanced to three different locations (Pond, Construction Site and Field), to ensure that it was taking the recordings which was important, and not the actual location.

Students who self-collected data were able to view graphs displayed on the data loggers' screens as they collected the data. This allowed them to make contextual connections to the graph shape. The students were asked to take multiple recordings, and were then given the opportunity to reflect upon the graphs and choose which data to use when they returned to the classroom.

Students who did not self-collect were given a talk in the classroom on data loggers to ensure they were introduced to the data loggers and that the only difference between the self-collected and the peer-collected group was that the self- group actually used the data loggers themselves.

2.3 Materials

2.3.1 Data Loggers

The study used Logbook GL data loggers (see Figure 1) provided by ScienceScope with additional plug in Sound Sensors with the range (30dB-110dB).

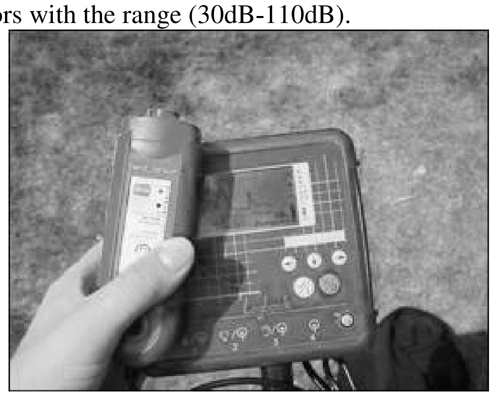


Figure 1 Logbook GL with additional Sound Sensor.

2.3.2 Software

The students used ScienceScope's Datadisc PT software to generate their graphs. Datadisc Explore PT was also used to show sound levels to half the students. Datadisc is a software package designed specifically for science education in schools and provides the ability to download data from the Logbook dataloggers, create graphs and tables of the data, annotate with labels and perform appropriate manipulation of the data to allow students to analyse the data they have collected.

2.3.4 Pre/Post Test

The pre- and post-tests consisted of questions designed to assess the student's ability to read a graph, draw a graph and correctly title and label graphs. These tests were based upon questions that arise in national Maths and Science examination papers for this age group. This meant that the question style would be familiar to the students. The language used in the questions also appropriately reflected this level. The pre- and post-tests also included questions on data reliability and validity, asking students to explain their choices. For instance the students were asked to consider what to do about a missing data point, should they replace it to a specific location, suggest it goes within a range or not to replace it. Additionally, in the pre- and post-test booklet the students were asked to rate statements using a 5 point Likert scale varying from Strongly Agree to Strongly Disagree such as 'My understanding of a graph is better if I have drawn it myself'. The post-test varied from the pre-test only in the numbers used for the graphs, the question phrasing was identical. The pre- and post-tests were counterbalanced across the students. The design of these questions was iterative with input from four teachers from different schools.

Question One required students to use a sound graph with three lines on it indicating three different locations. Students were asked to choose which location was the quietest and then report the sound level for each location at a set time. Students were also asked to consider whether they would replace missing data and explain their reasoning. This question was designed around a question which is common to exam papers at this stage "On the graph, circle the result which does not fit the pattern. Suggest one reason for this result." While our question was not identical, it uses the same underlying understanding by assessing how the students handle odd, anomalous and missing data. We chose to ask the students to explain their choice to gain insight into their reasoning, in contrast to many such questions in which students are often asked to make judgements without the chance to justify them.

Question Two provided students with a table of data and asked the students to plot the data points and draw a line of best fit. This reflects a type of question which is common to science examinations which asks students to finish plotting a graph or to plot a table of data. We included this question to see how students chose to scale their graphs and whether they would correctly label and title them.

Question Three followed on from question two by asking students to provide a graph with axis labels and a title. Analysis of exam papers shows that this is a skill students of this level should hold. Throughout the papers students are asked to add appropriate scales and labels to graphs.

Question Four took inspiration from exam questions which asked students to report what was happening at different times of the graph. We adapted the question so instead of focussing on differences within a graph, the students were asked to consider three lines on the same graph and use the shape of the graphs to infer which graph represented which location.

2.3.5 Work book

The work book provided the students with a guide to what they were doing. Initially it introduced the students to the locations. Location A represented the location that the student or their partner would visit. The actual location varied dependent upon which counterbalancing group they were in: Construction Site, Pond or Field. They were also told about Location B which was a Car Park, but none of the students actually visited the car park. The students were asked to make predictions about the two locations with regard to sound levels and they were also asked to explain their choices. The workbook also included space for observations which the students filled out following the data logging.

The next section asked them to answer questions by interpreting their graphs, and also to think about how the graphs matched their initial expectations. Finally the conclusions section asked them to consider if the study had been a fair test, how they might change it and what difference this might make.

2.4 Procedure

The study was held over three days with a different school attending each day. The procedure, however, remained identical. Ethical approval was gained for the study and each student and their parents/guardians gave their consent to participate and to be recorded. The activities were video recorded throughout.

2.4.1 Introduction and Pre-Test

At the start of the day the students were given an introduction to the classroom and a summary of what they would be doing during the day. It was stressed that there were no right or wrong answers and that we were interested in reasoning rather than correct answers. The students were placed into groups randomly (assigned a number, colour and shape) and each was asked to complete the first booklet (pre-test) and the first section of the main workbook. They were given 30 minutes to complete this individually.

2.4.2 Data Collection

The students were split into two groups, Self-Collected and Peer-Collected.

2.4.2.1 Self-Collected.

These students were given individual data loggers and were shown how to use them. Each student then visited one of three possible counterbalanced locations and spent 15 minutes taking a number of twelve-second recordings and choosing which recording they would like to analyse. At the construction site location the students stood on one side of a high safety wall with construction workers on the other side. They took recordings of the sounds made at the site. The students who visited the pond took recordings of the ducks and the fish in the water (see Figure 2). Finally the students who went to the field went to an area which is often quiet so they recorded sounds of birds, and the occasional person walking past.

Figure 2. 'Self' group students collecting data by the pond

2.4.2.2 Peer-Collected.

These students were given a talk on sound recording and shown a data logger connected to a computer. They were given the opportunity to interact (without holding the logger) by seeing how loud and quiet they could be, this provided them with an opportunity to understand a data logger without gaining the context of actually taking a recording themselves. When the 'Self' students returned they were asked to get into their pairs with the 'Peer' students. The students who had been outside to use the data loggers were asked to describe to their partners what their experience had been like. All the students were asked to record these observations in their workbooks.

The students were then given a break while the data was uploaded into the ScienceScope software to produce graphs and tables of data for the next stage.

2.4.3 Graph Production

The students were all given 40 minutes to explore their data and produce graphs. They were divided into three groups: Software-Produced, Manually-Produced and Pre-Produced.

2.4.3.1 Software-Produced.

These students were shown how to connect data loggers to computers and use ScienceScope software to upload their data files and explore their graphs. Each student was given the opportunity to upload data collected by them/their partner and data collected by the researcher. Students were encouraged to explore the software, and personalize their graphs by adding labels, titles and colour.

2.4.3.2 Manually-Produced.

These students were given two tables of data; one included the data collected by them/their partner and a second table of data collected by the researcher. The students were given all the data points for each of the twelve-second recordings but they were told they could choose which data to display in each graph and were given ideas such as choosing every other point, randomly picking 10 points or choosing a section of time. The original data table included 96 data points spanning 12 seconds of data. By providing the students with the whole data set it allowed the students to see all the available data while giving them control to graph what they felt was important (See figure 3).

Figure 3. 'Manual' group students considering their graphs.

2.4.3.3 Pre-Produced.

The students in this group were given two graphs, one graph for Location A (data collected by them or their partner) and one graph for Location B (researcher collected). They were given poster paper and pens and asked to annotate each graph considering possible explanations for peaks and troughs.

2.4.4 Workbook and Post Test

All students were asked to spend 45 minutes completing the workbook, which asked questions about the graphs that they had been working on, and then to complete the post-test booklet.

2.4.5 Debrief

Finally the students were given an overview of the research area highlighting their contribution and asked to make comments on the day.

3. RESULTS

In the following section we report the results from the pre- and post-tests. These are divided by questions and include both quantitative and qualitative analysis of learning and motivation.

3.1 Learning

ANOVA results are reported in table one. Results showed all students independent of groupings started off at the same level. Analysis of post test performance indicated an interaction between Collection and Presentation groups with students in the Peer-collection group showing a significant difference in their post-test result, dependent on their Presentation group. Students in the Self-collection group showed no difference in their post-test regardless of the presentation group. Post-hoc analysis of the Peer group using the Tukey test showed a significant difference between the Manually-Produced condition (M=6.33) and the Pre-Produced condition (M=4.50) p=0.025, with students in the Pre-Produced group producing higher post-test scores than those in the Manually-Produced group. The difference between the Software-Produced condition (M=6.00) and the Manually-Produced condition is also nearing significance p=0.06, leaning towards the Software-Produced students on average performing better than those in the Manually-Produced condition.

Table 1. ANOVA results for Question One

Condition	Degrees of Freedom	F Value	P Value
Pre-Collection	1,36	0.143	>0.05
Pre-Presentation	2,35	1.100	>0.05
Post-Collection	1,36	.042	>0.05
Post-Presentation	2,35	2.671	>0.05
Peer Collection*	2,16	4.922	<0.05*
Self Collection	2,16	0.350	>0.05

*indicates significant result at 0.05 level

3.1.2 Question Two (assesses ability to draw a graph and label it correctly)

ANOVA results are reported in table two. Analysis of change between pre- and post-test using a Repeated

Measures ANOVA shows a significant change in scores for all data. Students show lower scores on their post-test (Mean= 5.46) compared to their pre test (Mean=6.21). Further analysis into Collection type revealed a significant change within the Self group with students performing worse on their post-test (mean=5.13) than their pre-test (mean=6.26). No significance was found within the Peer group indicating that students who Self-collected got significantly worse while those who Peer collected did not.

Further analysis into Presentation type revealed a significant difference for the Manually-Produced group with students performing worse on their post-test (mean=4.92) than their pre-test (mean=6.67) No significant difference was found for Software- or Pre-Produced. These results indicate that students in both the Self group and the Manually-Produced group performed significantly worse at post-test.

Table 2. ANOVA results for Question Two

Condition	Degrees of Freedom	F Value	P Value
Pre-Collection	1,36	0.016	>0.05
Pre-Presentation	2,35	.466	>0.05
Post-Collection	1,33	.619	>0.05
Post-Presentation	2,32	.520	>0.05
Change All**	1,34	7.432	<0.01**
Change Collection*	1,15	16.96	<0.05*
Change Peer	1,18	.503	>0.05
Change Manual*	1,11	5.923	<0.05*

*indicates significant result at 0.05 level
**indicates significant result At 0.01 level

3.1.3 Question Three (assesses ability to label graphs) and Question Four (assesses ability to match possible locations with line graphs)

No significant differences were found for questions three and four.

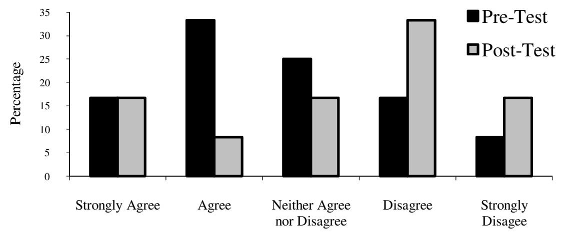
3.2 Motivation

In the pre and post test there were 6 statements assessed using a 5 point Likert Scale from strongly agree to strongly disagree. Of the 3 statements assessing motivation, one statement "I enjoy using computers to draw graphs" was shown to be non significant, while the other two revealed significant differences. "I think collecting data is a waste of time" and "I like working with data I have collected."

3.2.1 I Think Collecting Data is a Waste of Time.

Analysis using a Wilcoxon shows responses changing to the statement was nearing significance z=-1.874, p=0.061. The mean of the negative ranks was 8.80 while the mean of the positive ranks was 9.77. Further analysis into the Presentation factor showed a significant difference z=-2.041, p<0.05, mean negative ranks was .00 and mean positive ranks was 3.00, before and after intervention for students who were in the Pre-Produced category. With the option "Disagree" being picked 16.7% pre-test and 33.3% post-test. "Strongly Disagree also became more popular (8.3% pre test, 16.7% post test) this indicates a positive change of opinion in response to 'I think collecting data is a waste of time'.

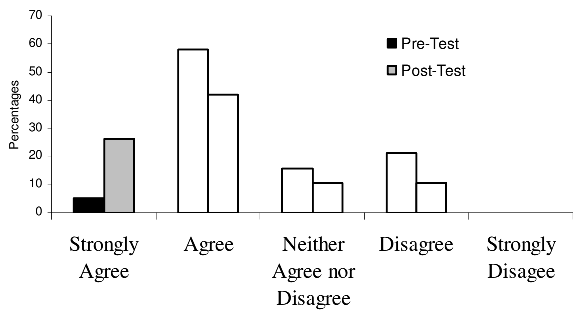
Graph 1. Change in responses to 'I think collecting data is a waste of time' for Pre Produced group.



3.2.2 I Like Working With Data I Have Collected

Analysis into the Collection factor showed a significant difference z= -2.460, p<0.05, mean negative ranks was 4.0 while mean positive ranks was 0.00, in response to 'I like working with data I have collected' before and after intervention for students who self-collect. Further analysis using the frequency tables showed that at post-test there were more Strongly Agree responses than at pre-test (29.4% of responses, compared to 5.3%).

Graph 2. Change in responses to 'I like working with data I have collected' for Self collected group



There were two questions that students completed within the workbook which also assessed motivation.

3.2.3 Which Set of Data Did You Feel More Comfortable Working With?

Initial analysis of responses to this question indicate that students in the Self group more often indicate Location A (the Student Site) (68.8%) than students in the Peer group (18.8%) The majority of students in the Peer group indicate that they found no difference between the two locations (62.5%). Analysis using Chi Square indicated a significant difference between the observed and expected frequency for collection type and which data students felt more comfortable with, (X2=8.541, *df*=2, p<0.05). While initial analysis of the presentation groups shows that 50% of students in the Pre-Produced group felt more comfortable with Location A, students in the Software- and Manually-Produced groups picked Location A only 40% of the time. This was shown to not be significant when analysed using Chi Square (X2=0.83, *df*=4, p>0.05)

3.2.4 Which Set of Data Do You Feel You Can Explain Better?

Initial comparison of the Collection group indicate that 60% of Self students felt they could explain Location A best compared to only 18.8% of Peer students. This was supported by a significant Chi Square result (X2=6.880, *df*=2, p<0.05). Analysis of presentation type showed no significant difference (X2=1.248, *df*=4, p>0.05).

Both of these questions indicate that students who collected the data themselves felt more comfortable with that data and felt that they could explain it better. This is shown clearly in the explanations given by the students;

Which data did you feel more comfortable with?

Student in the Self Group *"Location A- Because this was the one I tested and it took less time to draw a graph because I understood the data better"* compared to a student in the Peer Group *"No Difference-I didn't go and find any data so it doesn't really matter to me which one I worked with"*.

Which set of data do you feel you can explain better?

Student in the Self Group *"Location A-Because with this one I know why the data was varied, however I couldn't find out why the other set of data was varied"* compared with student from the Peer Group *"No Difference-I think I understand each both the same because I didn't go out and collect the data so I was just working with the data I got given and it didn't matter which one I had"*.

4. DISCUSSION

This experiment was designed to answer three specific hypotheses:

1. Motivation will improve for data acquired in context (self-collected)

This hypothesis was confirmed, with those who self-collect, regardless of graphing, provide significantly more positive results at post-test to 'I like working with data I have collected'. The self-collected group is significantly more likely to state they are more comfortable working with data from the location they visited compared with the peer-collected group, and chose this location as the one they could explain better more often than those in the peer-collected group.

2. Understanding will improve for data acquired in context (self-collected)

This hypothesis was not supported, with those in the self-collected group performing worse at post-test specifically on their ability to draw a graph. This unexpected result appears, from observation, to be down to a fatigue issue, with two students failing to complete the post-test graph and a number of others only partially completing it.

3. Pre-generated graphs will be better understood if students acquired the data themselves.

Interestingly, the results showed the reverse of this hypothesis with students who collected the data showing no difference between production types, while students who used peer data showed a better post test score when they used pre-generated graphs.

In the following sections, we discuss the implications of our findings for the importance of focussing on interpretation, methods and techniques for assessment, and the relevance of motivation for hands-on learning.

4.1 Motivation for Learning

Our data shows no immediately observable relationship between increasing motivation and an impact on understanding. That such a relationship would emerge in the long term needs to be established if sensors are to be used more, and indeed if methods of assessment are to be redesigned to reflect this pedagogical change. We are therefore currently carrying out long-term studies of an environmental science group using the most up-to-date sensors and displaying readings using tailored software, mapping these observations onto the real environment and adding contextual data (particularly digital photos), to explore the opportunities and the demands facing this type of work in a real setting.

While our results were not always as we predicted our study design has enabled us to gain valuable insight into the subtleties of data collection and graph production. It seems that in terms of motivation self-collection of data is important. However, within the current study this does not necessarily transfer into better performance on post-tests. It also seems that the pre-produced group were more motivated about collecting data, potentially because they had the opportunity to annotate their graphs, so connected the graphs with the importance of knowing the context, whereas students in the manually-drawn and software groups showed less annotation. The motivation factor of hands-on learning found in the current study is in line with the literature (Dewey 1964). Beyond this confirmation, however, we have provided new insights around peer-collected data and the effect on interpretation. Our results hint towards advantages for software-produced graphs. This may be affected by the length of the intervention period; in this experiment it was only a 30-minute intervention. The next stage of this research is to develop an understanding of how we can tap into this increased motivation to produce a better standard of work and understanding. We plan to carry out a delayed retention test after several months with the same students in order to see if there is any difference in the results following a delayed period. Do they retain more information over the long term if they self-collected? Are students in the pre-produced group still performing better than the hand-drawn groups?

This research has implications for designers of educational hardware and software. This study reveals the importance of breaking down the elements of hands-on learning to see where the advantages lie. The importance of constructing the data oneself was crucial to explore in terms of both motivation and learning benefit. This breakdown is key to designers for these kinds of activities, because without pinpointing the advantage clearly it is difficult to design technologies in such a way that they can be tailored to effectively aid learning or motivation or both. If designers were to just access the results of qualitative research in this area, it would be very hard to separate the factors that are contributing to the 'advantage' of a hands-on approach. Our study shows that the relationship between automation and learning is not simple at all – in fact, in our example, automating the process of graphing data highlighted an important change in performance under the subsequent post-test.

5. CONCLUSION & FUTURE WORK

While we have taken a step in the direction of moving some of our observations into exploring more concretely how these factors really are having an impact on learning, we still have some way to go. We need to continue to explore the importance of contextual data. Sensors enable ever increasing functionality, such as adding media in real time, and displaying a graph immediately on the sensor display, (rather than just the raw data). Initial work has found these to be important to understanding and reflecting upon data (Stanton et al 2005). However, we now aim to break these down and take a deeper look by carrying out specific studies looking at different types of contextual data.

We have begun to examine the effects of collecting and manipulating scientific data oneself, and how this impacts on motivation and learning. While we find clear motivation effects it is less clear how self-collection in the real world affects learning and we find those who create their own graph manually are worse at post-test than those who annotate pre-produced material. Importantly we have employed a range of methods from observation to experimental design in tackling this question. This work is important to those studying learning with mobile devices and designers of hardware and software to support learners.

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Mobile Self-Efficacy in Canadian Nursing Education Programs

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Abstract

The purpose of this study was to assess the self-efficacy of nursing faculty and students related to their potential use of mobile technology and to ask what are the implications for their teaching and learning in practice education contexts. We used a cross-sectional survey design involving students and faculty in three separate nursing education programs in Western Canada. Fifty-six faculty members and students completed the survey in March, 2010. Results showed a high level of ownership and use of mobile devices among our respondents. Their overall average mobile self-efficacy score was 72.11 on a scale of 100, indicating that they are highly confident in their use of mobile technologies and prepared to engage in mobile learning.

Keywords

Self-efficacy, motivation, mobile learning, nursing education, practice education

Previously, we (Kenny, Park, Van Neste-Kenny, Burton, & Meiers,, 2009a, 2009b) have argued that, in nursing education, new approaches and tools are needed to support the teaching and learning of nursing students at a distance and that mobile learning (m-learning) could potentially be highly effective in this instructional context. Koole (2009; Koole, McQuilkin & Ally, 2010) defines m-learning as a process resulting from the interaction of mobile technologies, human learning capacities, and the social aspects of learning. In the nursing education context, it supports learning that is more situated, experiential and contextualized within the specific instructional domain and affords the use of up-to-date and accurate content (Kukulska-Hulme & Traxler, 2005). In nursing practice education, m-learning has the potential to bring the instructor, peers and resources together virtually at the point-of-care, especially when indirect supervision models are used, to support the students' safety and evidence-informed practice.

1.1 Literature Review

In a recent study (Kenny et al., 2009a), we concluded that it was feasible and desirable to implement the use of mobile learning in nursing practice education in particular, but we also determined that such use must be fully integrated into the curriculum to be effective. In addition, our research indicated that it was necessary to move beyond descriptive studies and to base further research in this area on established theory.

This paper reports on a study that is situated as a precursor to a planned longitudinal study examining the applicability of the Community of Inquiry model (Garrison, Anderson & Archer, 2001) to mobile learning contexts. As such, the study was intended to provide further information on the current state of the use of mobile technology in nursing education and on its potential implementation in practice education. We sought to understand the predisposition of faculty and students to make use of this new technology in their teaching and learning.

In particular, we were interested in our respondents' level of motivation to engage in m-learning. In our previous study (Kenny et al., 2009a), nursing students reported feeling quite comfortable with mobile devices. They found them easy to use and to be useful in their practice education courses. However, despite these positive assessments, when offered the opportunity to use mobile devices in their courses, they used them sparingly and limited this use to one or two nursing resource applications. Our results also revealed that our respondents' expressions of confidence in their ability to learn how to use mobile devices were based on previous experience with desktop computing rather than with mobile devices per se. Therefore, we turned to the literature on motivation; specifically the concept of self-efficacy (Bandura, 1997), for guidance and to delve more deeply into how well nursing students and faculty were prepared to use mobile learning in their courses.

Self-efficacy refers to the personal beliefs of individuals that they are capable of learning and performing particular behaviors. As such, it is not a generalized trait, but is domain specific (Bandura, 1997; Schunk, 2008). Students' perceptions of self-efficacy have been found to influence their decisions about the choice of activity in which they engage, their emotional responses (e.g., stress and anxiety) when performing the behaviors, and their persistence in carrying out these actions (Bandura, 1997; Compeau & Higgins, 1995; Schunk, 2008). As such, self-efficacy has been shown to be an important mediator of many forms of achievement behaviour (Schunk, 2008).

Individuals' self-efficacy judgments differ on three interrelated dimensions: magnitude, strength, and generalizability (Bandura, 1997, 2006; Compeau & Higgins, 1995). Magnitude refers to the level of task difficulty individuals believe they can attain, i.e., those with high self-efficacy will see themselves as able to accomplish difficult tasks and those with low self-efficacy will see themselves as only able to execute simple forms of the behaviour. Self-efficacy strength refers to the level of the confidence that individuals have regarding their ability to perform a tasks (e.g., their ability to learn and use mobile devices). Finally, self-efficacy generalizability reflects how much an individual's judgment is limited to a particular domain of activity. In mobile learning, the domain includes the characteristics of the specific mobile technology with which users interact (Koole, 2009; 2010). Thus, individuals with high mobile self-efficacy generalizability would expect to be able to competently use a variety of different devices, while those with low computer self-efficacy generalizability may perceive their capabilities as limited to particular devices, especially those with which they have had experience.

Specifically, while a significant body of research exists on learners' feelings of self-efficacy concerning computer technology, online learning, and even podcasting (e.g., Compeau & Higgins, 1995; Hodges, Stackpole-Hodges, & Cox, 2008; Johnson, 2005; Kao & Tsai, 2009; Koh & Frick, 2009; Liang and Wu, 2010; Loftus, 2009), this concept does not appear to have been examined in a mobile learning context.

1.2 Methodology

The purpose of this study then was to assess the level of self-efficacy of nursing faculty and students related to their potential use of mobile technology and to ask what might be the implications for their teaching and learning in practice education contexts. We used a cross-sectional survey design involving students and faculty in three separate nursing education programs in Western Canada: a Post Licensed Practical Nurse to Bachelor of Nursing (Post LPN) program and an Advanced Nursing Practice (ANP) offered by a university in one province and a Bachelor of Science in Nursing (BSN) program offered by a community college in collaboration with a local university in another province. At the time of the survey, there were 240 students and 33 faculty members in the post-LPN program and 675 students and 18 faculty members in the ANP program. There were also 137 students and 21 full time and sessional faculty members in the BSN Program. Therefore, there were 1124 potential participants.

To investigate these issues, we developed an online survey instrument to gather demographic information and mobile use data and to administer a mobile use self-efficacy questionnaire. Bandura (1997, 2006) stresses that self-efficacy should measure particularized judgments of capability that may vary across specific realms of activity.

The mobile self-efficacy questionnaire used in this study was based on a computer self-efficacy instrument developed by Compeau and Higgins (1995) and slightly modified for a mobile learning context. The modification consisted of changing the stem of the question from "I could complete the job using the software package..." to read, "If I had a mobile device such as a smart phone or 3G phone (e.g., iPhone), I could use it in my Nursing instruction…" See Appendix A for the mobile self-efficacy questions. Respondents were asked to answer each question by first answering yes or no and then completing a Likert-style scale of 1 – 10 for their level of certainty about each yes answer. Bandura (2006) also stresses the need for item homogeneity within a domain-relevant scale and advises authors to calculate a Cronbach's alpha coefficient to assess the internal consistency reliability of the scale. For our survey results, alpha was 0.761 indicating that the mobile version of the scale can be considered reliable.

1.3 Results

1.3.1 Demographic information

Fifty-six faculty members and students completed the survey in March, 2010, for a response rate of 4.98%. Table 1 provides the breakdown of respondents by program type, status as faculty or student, age and gender.

Table 1. Demographic Information

Factor	Grouping	N	%
Program	Post LPN	17	30.4
	ANP	26	46.4
	BSN	13	23.2
Status	Faculty	12	21.4
	Student	44	78.6
Age group	18	3	5.4
	26	10	17.
	30	11	19.6
	40	19	33.9
	50	12	21.4
	60+	1	1.8
Gender	Male	4	7.1
	Female	52	92.9

The Advanced Nursing Practice program provided nearly half of the respondents in this study. In addition, nearly 77% of our respondents were reported being 30 years or more in age and a full 57% over 40 years, indicating that the a substantial majority were mature adults. Ninety-three percent were female, while only 7% were male.

1.3.2 Mobile Ownership and Use

In order to more fully understand our respondents' mobile self-efficacy scores, it was important to learn if they owned mobile devices, since the familiarity of ownership would clearly impact their assessment of their capability to use such a device. All 56 respondents indicated they owned a mobile device of some sort.

Table 2 shows the types of mobiles owned by faculty and students in each nursing program. Twenty-three percent reported owning a simple classic mobile phone, while 27% had a cell phone with a camera or MP3 player built in. Eighteen percent indicated they possessed a smart phone (e.g., a Blackberry), while 21% had a 3G phone (e.g., an Apple iPhone). Eleven percent chose the "other" category and reported having a variety of devices, some of which would have fit as well under the smart phone category, but also included the Apple iPod touch and intention to purchase the Apple iPad, which was not yet on the market at the time of the survey.

Table 2. Own a mobile? Crosstabulation by Program

	Type of					
Program	Phone only	Phone & camera	Smart phone	3G phone	Other	Total
Post LPN	6	5	2	1	3	17
ANP	3	6	5	9	3	26
BSN	4	4	3	2	0	13
Total	13	15	10	12	6	56

Table 3 shows the level of mobile ownership by age grouping. Since the age groups varied in size and two age groupings (18-25 and 60+) were considerably smaller than the other groups, calculating percentages would be misleading. However, it is interesting to note that majority of 3G mobiles were owned by respondents in the middle age grouping (individuals aged 30-49).

In addition to learning what types of mobile devices our respondents owned, it was also important to detail in what ways and how much they used their devices in their daily lives as well as in teaching and learning in order to explain their levels of mobile self-efficacy. Table 4 shows what mobile features our respondents reported using on a weekly basis. Note that this was an open choice question allowing respondents to select more than one feature such that the total number of choices for each item does not equal the number of respondents.

Table 3. Own a mobile? Crosstabulation by Age

	Type of					
Group	Phone only	Phone camera	Smart phone	3G phone	Other	Total
18	0	1	1	1	0	3
26	2	3	3	1	1	10
30	2	2	2	4	1	11
40	5	5	2	6	1	19
50	4	4	1	0	3	12
60+	0	0	1	0	0	1
	13	15	10	12	6	56

Regardless of other choices, it is perhaps not surprising that nearly all (91%) of our respondents reported using their mobiles weekly for telephone services. The exception likely would have been those owning an Apple iPod Touch, which can afford email and Internet access via WiFi connectivity, but does not function as a mobile telephone. In addition, half of our respondents reported also using their mobiles to do email, browse the Internet and text message, and 34% used health applications on their devices weekly.

Table 4. Mobile Features used once / week by Program

Program	Phone	Camera	Email	Internet	SMS	Audio msg	Word Pro	Health apps
Post LPN	15	2	4	2	4	1	2	2
ANP	23	9	19	17	17	1	2	16
BSN	13	5	4	7	7	2	3	1
Total	51	16	27	26	28	4	7	19

To more fully determine how our respondents made use of their mobiles in their teaching and learning, we asked them to indicate which features or applications they used at least one time to support their learning as a student or teaching as a faculty member. Perhaps the most significant answer to this question was that nearly 36% of our respondents reported not using their mobiles in any way in their teaching and learning. Of those who did use their devices in some manner for this purpose, 53% used them for email, 50% for health applications and 47% used the telephone. One third of respondent also indicated using their mobiles for word processing, which is interesting given the limited capabilities of most mobiles in this regard.

Table 5. Mobile Features used in nursing by program

Program	Phone	Camera	Email	Internet	SMS	Audio msg	Word Pro	Health apps	Not used
Post LPN	3	1	4	3	0	1	4	2	9
ANP	7	1	11	12	5	1	5	15	6
BSN	7	2	4	6	2	0	3	1	5
Total	17	4	19	21	7	2	12	18	20

1.3.3 Self-Efficacy

All of our respondents reported owning a mobile device and most used it weekly at least to make telephone calls. How did such evident familiarity with the domain of mobile use translate into feelings of self-efficacy? The overall average mobile self-efficacy score was 72.11. A univariate ANOVA (Table 6), when testing at $\alpha \leq .05$ level, showed no statistically significant main effects between the mean self–efficacy scores and program, faculty vs. student, or age grouping. This was also the case for gender. There was however, a statistically significant interaction between program type and age grouping.

Table 6. Univariate ANOVA

Source	df	Mean Sq.	F	Sig.
Program	2	995.815	2.362	.111
Faculty	1	66.527	.158	.694
Age	5	386.861	.917	.482
Gender	1	274.148	.650	.426
Program * Faculty	2	707.400	1.678	.203
Program * Age	7	1113.562	2.641	.028
Faculty	1	952.885	2.260	.143
Age Group * Gender	1	193.600	.459	.503
Error	32	421.685		

Table 7 outlines the mean mobile self-efficacy scores by program type. All program means were negatively skewed, indicating that self-efficacy scores in each group tended to be clustered above the mean. The self-efficacy scores were highest on average in the ANP program and lowest in the Post LPN program. However, the Post LPN group had one score of 0, which appears to be an outlier, since the next lowest score was 19, also in this group and the scores in the group are negatively skewed.

Table 7. Self-Efficacy Scores by Program

Program	N	Mean	Median	S. D.	Min	Max*	Skew
Post LPN	17	61.29	64.00	24.32	0	90	-
ANP	26	77.31	78.00	19.70	25	100	-
BSN	13	75.85	77.00	23.43	25	100	-
	56	72.11	75.00	22.81			

* The maximum possible score was 100.

Interestingly, while the ANOVA (Table 6) showed no main effect for self-efficacy scores by program level, a Tukey HSD post hoc test (Table 8) showed a statistically significant difference between the mean scores for the Post LPN and ANP programs.

Table 8. Tukey HSD Post Hoc Test – Self-Efficacy * Programs

	Mean Diff.	Std. Error	Sig.	95% Confidence	
				Lower	Upper
ANP	16.01*	6.405	.045	.27	31.75
ANP	1.46	6.975	.976	-	18.60
BSN	14.55	7.566	.149	-	33.14

* The mean difference is significant at the 0.05 level.

Faculty mobile self-efficacy scores (Table 9) were nearly 10 points lower on average, which would seem to indicate a substantial difference. However, since the results were negatively skewed, the differences in median scores were less pronounced and the ANOVA (Table 6) indicated that the difference was not statistically significant.

Table 9. Self-Efficacy Scores: Faculty - Students

	N	Mean	Median	S.	Min	Max	Skew
Faculty	12	64.75	69.50	29.95	0	100	-
Students	44	74.11	76.50	20.42	19	100	-
Total	56	72.11	75.00	22.81	0	100	-

Table 10 provides the breakdown of mobile self-efficacy by age. While the 18-25 age group appears on average to have a much higher sense of self-efficacy than any other group, this may simply reflect the small numbers in the group.

Again, an ANOVA (Table 6) indicated that the difference was not statistically significant.

Table 10. Self-Efficacy Scores by Age Group

Age	N	Mean	Median	S.D.	Min	Max	Skew
18	3	90.67	95.00	12.10	77	100	-
26	10	72.90	75.00	16.86	45	100	-
30	11	78.82	88.00	24.11	19	100	-
40	19	67.74	71.00	26.41	0	100	-
50	12	67.92	75.00	21.92	25	95	-
60+	1	68.00	68.00	.	68	68	.
Total	56	72.11	75.00	22.81			

The one statistically significant effect revealed by the ANOVA was an interaction between self-efficacy scores by program and age combined. However, it is likely that this was an artefact of the small N of 3 in the 18 – 25 age group. All of three individuals had high self-efficacy scores. One was in the ANP program and the other two in the BSN program, both of which had substantially higher mean self-efficacy scores than the Post LPN program. Figure 1 displays a cross plot of the self-efficacy scores by age and program type and demonstrates that the 18-25 age group appears to be an outlier.

Figure 1: Self Efficacy Scores by Age Grouping

1.4 CONCLUSIONS

We noted previously that our earlier research (Kenny et al., 2009) has shown that it was both feasible and desirable to implement the use of mobile learning in nursing practice education. M-learning has the potential to bring the instructor, peers and resources together virtually at the point-of-care to support the students' safety and evidence-informed practice. As such, this study was intended to assess the current state of the use of mobile technology in nursing education and, more specifically, to investigate the predisposition of faculty and students to make use of this new technology in their teaching and learning. In our previous study, nursing students had reported feeling comfortable with mobile devices and found them easy to learn, but also used them sparingly. Therefore, we turned to the literature on motivation; specifically the concept of self-efficacy (Bandura, 1997) for guidance and to delve more deeply into how well nursing students and faculty were prepared to use mobile learning in their courses.

1.4.1 Demographics

We surveyed 56 nursing faculty and students across three different types of nursing programs in two provinces in western Canada. While the majority of our respondents were 30 years or older, they represented all age groups who could be, or are likely to be, involved in nursing education. Therefore, while the results have to be interpreted with caution in terms of generalizing beyond these programs, our study does provide a snapshot of how well nursing faculty and students are prepared to engage in mobile learning.

The results of the demographics portion of our survey, for instance, revealed that all respondents owned mobile devices and that the type of device owned ranged evenly across the different levels of mobile technology available. For instance, twenty-three percent reported owning a simple mobile phone with no other features, while nearly 40% had a smart phone or 3G device. Furthermore, the ownership of the more sophisticated mobiles was not restricted to one age group, but spread evenly across the groups.

Additionally, our respondents reported using their devices in a variety of ways on a weekly basis. While their highest level of use (91%) was for making telephone calls, those owning mobiles with a range of capabilities also employed a number of other features on a regular basis. Half of our respondents reported also using their mobiles for email, to browse the Internet, and to send text messages. Thirty-four percent used health applications on their devices weekly. This is consistent with the use of mobile devices in Canada generally. A recent online poll (Ipsos Reid, 2009, May) revealed that seventy per cent of wirelessly connected Canadians are accessing the mobile Internet for personal e-mail and more than one quarter are browsing the web from their mobiles at least once a day.

At a minimum, then, we can state with some certainty that nursing faculty and students, as represented by our sample, are familiar with the use of basic mobile technology and that a substantive proportion are knowledgeable about devices providing a variety of functionalities. In terms of comfort with the device aspects of m-learning (Koole, 2009), our respondents appeared prepared to engage in mobile learning.

However, currently, our respondents are not using their mobiles as much in nursing education as in their personal life. Nearly 36% of our respondents reported not using their mobiles in any way in their teaching and learning. Of those who did use their devices in some manner for this purpose, 53% used them for email, 50% for health applications and 47% used the telephone. It should be noted here that none of the nursing programs surveyed were formally integrating the use of mobiles into their curriculum. From our past work (Kenny et al., 2009), we had concluded that such integration was necessary for mobile learning to be successfully implemented and these results appear to support that conclusion in that our respondents were not automatically making use of their mobile devices in their teaching and learning.

1.4.2 Self-efficacy

Self-efficacy refers to individuals' personal beliefs that they are capable of learning and performing particular behaviors. More specifically, self-efficacy appraisals reflect the level of difficulty individuals believe they can surmount. The stronger the sense of personal efficacy they possess, the greater will be their perseverance and the higher the likelihood that they will perform the chosen activity successfully. Individuals' self-efficacy judgments differ on three interrelated dimensions: magnitude, strength, and generalizability (Bandura, 1997; Compeau & Higgins, 1995).

Bandura (2006) describes the assessment of self-efficacy as follows:

> In the standard methodology for measuring self-efficacy beliefs, individuals are presented with items portraying different levels of task demands, and they rate the strength of their belief in their ability to execute the requisite activities. They record the strength of their efficacy beliefs on a 100-point scale, ranging in 10-unit intervals from 0 ("Cannot do"); through intermediate degrees of assurance, 50 ("Moderately certain can do"); to complete assurance, 100 ("Highly certain can do") (p. 312).

The average mobile self-efficacy score for our respondents, as a group, was 72.11 and these results were negatively skewed. This is a rating mid-way between moderately and highly certain and reflects a reasonably high level of confidence in their ability to make use of mobile technology. Overall, then, if our sample is at all representative, it appears that nursing faculty and students, at least in western Canada, have a strong sense of mobile self-efficacy and this augurs well for the implementation of mobile learning in their curricula.

Furthermore, this level of self-efficacy was not restricted to specific program levels or age groups. The median self-efficacy across programs ranged from 68 for the Post LPN program group to a high of 78 for the ANP program group. As a main effect in an ANOVA, this difference was not statistically significant, although the difference was shown to be statistically significant with a more sensitive Tukey HSD post hoc test. The Post LPN program (Post Licensed Practice Nursing to Bachelor of Nursing) students are individuals who originally received a two year diploma in nursing and have returned to school to upgrade their credentials to the baccalaureate level. The ANP (Advanced Nursing Practice) program, on the other hand, is a post baccalaureate certificate. While more specific data about our respondents' levels of education was not gathered, it is probable that students, and even faculty (who are all employed on a part time basis by the university), in the Post LPN program were comparatively less educated, and possibility less experienced, than in those in the ANP program. Higher levels of education and experience could well contribute to an individual's sense of self-efficacy in learning contexts.

The median self-efficacy scores by age ranged from a low of 68 to a high of 95, which would indicate that all age groups minimally demonstrated a stronger than moderate level of mobile self-efficacy. With a median score of 95, the 18–25 age group had an exceptionally high level of self-efficacy. However, this group was represented by only three individuals and it is uncertain how representative they may have been of their age group. Further, while the mean scores appeared to generally decrease with age, the second highest median score (88) was in the 30-39 age group and there was no main effect for age in the ANOVA. Therefore, we found no reason to assume there was a relationship between age and self-efficacy among our respondents.

Similarly, while faculty mobile self-efficacy mean scores (64.75) were nearly 10 points lower on average than those of the students (74.11), the median scores were closer (a median score of 69.5 for faculty and 76.5 for students). Moreover, the ANOVA once again indicated that the difference was not statistically significant.

Overall, then, the nursing faculty and students in our sample appeared familiar with current mobile technology and many of its features. They also demonstrated high levels of mobile self-efficacy. On this basis, it is reasonable to conclude that they are well prepared and strongly motivated to engage in mobile learning.

1.4.3 Future Research

Issues of learner motivation in general, and the construct of self-efficacy warrant further investigation in the domain of m-learning. In terms of the present study, given the large numbers of faculty and students available to us, the response rate for our survey at just under 5% was very disappointing and certainly well below the level needed to be confident that our sample was representative of the greater population of nursing students and faculty. Therefore, it would be highly worthwhile to repeat this study to attain higher sample sizes.

Further, our analysis of mobile self-efficacy focused mainly on an assessment of the strength of the relationship. It would be useful, both in terms of further analysis of our current data and for future studies, to explore the dimension of generalizability by conducting a microanalysis of the responses to specific items in the scale. For instance, in our previous study (Kenny et al., 2009), while we provided a 2 hour orientation to the mobile devices used in the study prior to their deployment, our respondents also reported being able to learn features of the devices on their own with the assistance of the device manual. Question 3 in our current survey pertained to exactly that issue, stating, "If I had a mobile device such as a smart phone or 3G phone (e.g., iPhone), I could use it in my Nursing instruction...if I had only the device manual for reference." Question 9, on the other hand, relates more to direct instruction, stating, "If I had a mobile device such as a smart phone or 3G phone (e.g., iPhone), I could use it in my Nursing instruction... if someone showed me how to do it first.." Both questions detail the degree to which an individual feels confident learning and managing a mobile device without direct assistance from faculty or other. Such questions have strong implications for whether or not to integrate teaching the use of mobile technologies into the curriculum.

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Appendix A: Mobile Self-Efficacy Scale Questions

	If I had a mobile device such as a smart phone or 3G phone (e.g., iPhone), I could use it in my Nursing instruction.
Q1	...if there was no one around to tell me what to do as I go.
Q2	...even if I had never used a device like it before.
Q3	...if I had only the device manual for reference.
Q4	...if I had seen someone else using it before trying it myself.
Q5	...if I could call someone for help if I got stuck.
Q6	...if someone else had helped me get started.
Q7	...if I had a lot of time to complete the task for which the device was provided.
Q8	...if I had just the built-in help facility for assistance.
Q9	...if someone showed me how to do it first.
Q10	…if I had used similar devices before this one to do the same task.

Design Heuristics for Balancing Visual Focus on Devices in Formal Mobile Learning Activities

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Abstract

This paper questions the design of mobile learning activities that lead students to focus on the mobile devices at the expense of interacting with other students or exploring the outdoor environment. In this paper, we present heuristics for design that can help students balance their focus between devices and the educational tasks at hand. These design heuristics are based on a field study we conducted with two groups of fifth grade students interacting with mobile devices in order to learn the concept of "area" in mathematics. The heuristics state that the mobile devices should let students assume roles, and be used by students as measuring tools. The mobile learning activities should require physical interaction with the environment, let teachers assume roles and encourage face-to-face communication and introductory activities should introduce unfamiliar aspects of the mobile learning activities.

Keywords

Mobile Learning, Situated Learning, Interaction Design, Human-Computer Interaction, Interaction Analysis, Activity Theory.

1. INTRODUCTION

Formal outdoor learning activities supported by mobile devices are commonly designed as one-time events, lasting only a few hours. In this short time students are asked, not only to solve some task outdoors but also to learn to cope with many conditions of the activity new to them. In Figure 1 we see two students participating in outdoor learning activities where they are using mobile devices to solve a geometry task. They are new to the mobile learning task, new to the specific mobile devices and new to the software application guiding them through their task. In this situation, it comes as no surprise when the students focus their attention on the device rather than on the outdoors environment. This is not a problem when the pedagogical goal is to bring students attention to the learning content displayed on the mobile device, while focus on devices becomes a problem when the pedagogical goal is to make use of the outdoor environment. With a situated learning perspective (Lave and Wenger, 1991), a strong visual focus on devices might be a sign of a problem. In this context we ask, *how do we design mobile learning tasks and activities so that the students' focus is balanced between the devices and the educational tasks at hand?*

This paper reports from a project called Math edUcation and pLayful Learning (MULLE), aimed at middle school students. The goal of the project is to design learning activities on geometry across indoor and outdoor contexts.

Figure 1: Strong visual focus on the mobile device

This paper presents (1) an analysis of students' visual focus on devices in an outdoor activity and (2) heuristics for designing mobile learning activities allowing students to balance their focus between mobile devices and the learning tasks outdoors. Analysis of episodes of the activity observed are performed using the task model (Sharples et al., 2007). Compared to other theoretical frameworks relevant to mobile learning research, the task model is a powerful analytical tool that can be used to identify individual aspects of the activity related to students' focus on devices. The design heuristics suggested are grounded in the analysis of the learning activity studied. Rely on

In this paper we argue that the question of balancing visual focus on devices with the learning goals given by the task is fundamental to pedagogies using mobile devices from a situated learning perspective (Lave and Wenger, 1991). Furthermore we suggest that balancing visual focus on devices with the learning goals given by the task needs to be taken into account from a design perspective.

1.1 Visual Focus on Devices

A recent critical review paper reports that roughly one third of mobile learning research projects strive to move learning away from the classroom to more natural environments (Frohberg et al., 2009). In the same review paper the authors noted that there is "very little work which discusses the placement of mobile tools as means of control" (p. 318) and that "[v]ery few Mobile Learning projects with physical context explicitly considered, positioned or focused the usage of mobile technology as instruments to gain transparency and steer flexible learning activities there." (ibid, p. 318). As noted in these research projects the field trials are done with small groups of students to facilitate collaborative learning. Some of these projects use mobile devices to not only present information about tasks to users, but also to control the flow of the learning activity in detail. This type of design is related to device-centric approaches that bring small groups of learners to maintain a strong focus on devices and device interaction. It is notable that strong focus on the devices are just reported in peripheral notes in research reports from these projects, and consequently strong device focus is seldom questioned or understood as a main research problem (Göth et al., 2006).

However, a few research reports point directly to the problem with students having difficulties balancing their focus. Cole and Stanton (2003) compares projects they have been involved in; KidStory, Hunting the Snark and Ambient Wood, and report that the children had problems focusing on anything else but the mobile device. Their analysis showed that the problem was that the device was displaying a continuous flow of information and their solution was to provide information only occasionally. Göth and colleagues (2006) reported that "[l]earners were found to be focusing on the screen of the device and not on the environment [...]" (p. 154). According to their analysis it is a problem of focus and they suggest us to design functionality for switching focus between physical environment and device. Göth and colleagues (2006) additionally point to the project Caerus (Naismith et al., 2005) where focus on the devices was reported to be a problem, with "a large amount of 'heads-down' interaction". The latest report we have found on strong focus on the device is a field trial of an Augmented Reality interface called the MapLens (Morrison et al., 2009), stating that "As a general overview, it becomes clear [...] that MapLens users concentrated more on the interface, but not the environment around them." (p. 1897).

This review of related research work suggests that the visual focus on devices is becoming a problem worth considering in mobile learning research. Furthermore from a situated learning perspective there is a need to search for solutions on how the design of mobile learning activities can help students balance their visual focus between devices and the educational task at hand.

2. METHOD

Starting out from the design heuristics from a previous study called GeoMath (GeM) (Eliasson et al., 2010, Spikol and Eliasson, 2010), we redesigned parts of the mobile learning devices and parts of the learning activities for the MULLE study. This was done through a co-design process (Penuel et al., 2007) with two teachers from the local primary school participating in the MULLE project. We evaluate the devices and the learning activities of the second design iteration through a study with two groups of three students. The analysis rests on interaction analysis (Jordan and Henderson, 1995) to find episodes relevant to visual focus on devices and the task model (Sharples et al., 2007) for the analysis of the selected episodes.

2.1 Data Collection

Data was collected using 2 close-up video cameras and 2 wide-angle video cameras. The video cameras were handheld HD cameras, operated by members of our research lab. The close-up cameras were to follow the student carrying the 'task device' (see 3.1) and the wide-angle cameras were to follow the whole group. For individual audio each of the six students was recorded using a small microphone that they carried on them. The microphones were 1 cm in diameter and connected via cable to an MP3 recorder each student carried in their pocket. For the analysis we used data from the close-up cameras (2 x 80 minutes) and selected recordings from the wide-angle cameras and the microphones.

2.2 Video Analysis

Three people from our research group, who were also involved during the data collection in the field, were engaged in the analysis. The interaction analysis method (Jordan and Henderson, 1995) was selected as it does not foreground any part of the activity, compared to for example critical incident analysis (Sharples, 1993), which has a focus on breakdowns. Video and audio sources were analyzed in search for episodes where focus on devices was especially strong and where it was notable that focus on devices was absent. The researchers took individual notes, and discussions on episodes in the video were kept to a maximum of five minutes. Audio sources were used as a complement when it was difficult to hear what the students were saying by listening to the audio track from the video.

The individual notes were compared and put together into one single list of episodes relevant to visual focus on devices. The combined list had 57 relevant episodes, which was reduced to 17 episodes. The criteria for keeping an episode were that the students' focus on devices was particularly strong or extraordinarily weak. The procedure was to give individual scores, followed by a discussion of which episodes to keep based on these scores. The final list contained 17 episodes distributed over 5 categories, namely *mobile clue*, *natural constraints*, *teacher support*, *reference to introductory activity* and *between tasks*. Two of the researchers crosschecked these remaining episodes to confirm the interpretation of them. The episodes were then analyzed using the task model.

2.3 Task Model Analysis

The task model was used for analyzing how the individual components of the activity system either constrain the mediation of learning by causing unwanted focus on devices or support the mediation of learning by decreasing or resolving unwanted focus on devices. For each episode, the task model allowed us to describe all aspects of the activity relevant for the subject to reach its' goal (object). Because of the structure of the task model, each description of an episode also includes which of the components tool, control, context or communication that contribute to the subject reaching its' goal. By looking specifically at the technological layer, we could compare the components identified in the analysis with the support that was part of the design of the activity. From analyzing each episode in this way, we were able to show if the students were relying on our design or if they had to rely on support not considered in the design of the learning activity.

The task model offers a set of concepts that can be used to describe an activity as a whole and as a system built up of components and the relationships between these components. Sharples and colleagues (2007) provides a structured task model presented as a triangle (see Figure 2).

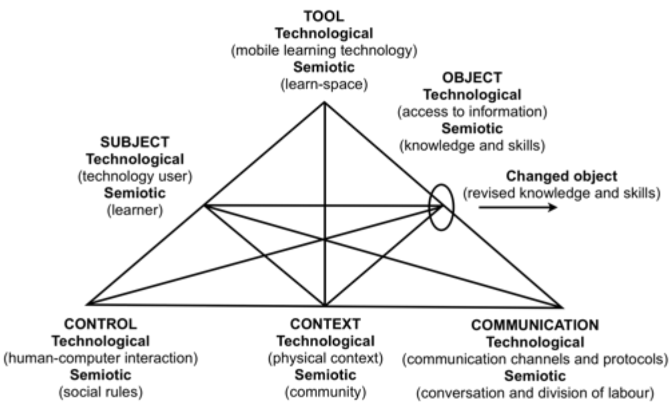

Figure 2: The task model (Sharples et al., 2007)

The task model has the basic component structure of subject-object-context, with the components tool, control and communication mediating the interaction between the basic components. The actions, thoughts and the final learning outcome are mediated as a result of the interactions between these components (Wertsch, 1991). The task model establishes a distinction between the technological and the semiotic layer. Figure 2 shows that the subject is seen as a learner in the semiotic layer and as a user in the technological layer. With this distinction the model presents one view for 'learning theorists' and one view for 'technology designers' (Taylor et al., 2006). It should be stressed that it is not a separation between the layers, but that the layers should be seen as forming a dialectic relationship where they can be moved together and apart, depending on what is to be emphasized in the analysis (Taylor et al., 2006).

In the task model the structure of the activity consists of the following six components and their relations: subject, tool, object, control, context and communication (see Figure 2), where the last three corresponds to rules, community and division of labor in the original activity system model (Engeström, 1987). Advantages of using the task model before the activity system model are the two layers (i.e. semiotic and technological) and the framing of mobile learning activities. The task model also has the advantage of describing an activity as collaborative, object-oriented and tool-mediated, which all are important aspects of the mobile learning activities observed.

Activity theory and especially the activity system model have a long tradition as a tool for analysis in the human-computer interaction (HCI) research field (Kaptelinin and Nardi, 2006). Compared to distributed cognition (Hutchins, 1995), which also has a large presence in HCI research, activity theory has a stronger emphasis on developmental processes. The advantages of using the task model before the conversational framework (Laurillard, 2009) are that the task model identifies which components are needed for an activity to be successful, where the conversational framework gives a detailed description of pedagogical processes, but no success criteria.

3. LEARNING ACTIVITY DESIGN

The design of the learning activities in MULLE builds on design heuristics (italics) that were developed in the first design iteration (Eliasson et al., 2010).

3.1 Changes from the First Design

Eliasson et al. (2010) observed that the students could take on roles corresponding to the functionality of the device they were currently using, which was expressed as a heuristic stating that: *Using two or more devices with different roles provides implicit roles for students.*

The outdoor activity in the first design was guided by one device called the main device, which contained the task and clues. A second device was only used as when the main device calculated the distance to it, as the difference between GPS positions of the devices (Gil and Pettersson, 2010). For the second design we let the second device also contain clue files, which was shown contextually depending on where in the activity the learners were (see Figure 3). We made this change to clarify the different technical functionalities of the devices, which then instead became "task device" and "clue device".

Figure 3: Mobile clue showing an animation of how to measure a rectangle using a smaller cardboard square

The observation that the students were in control of the activities, using devices as tools, led to a heuristic stating that: *Approaching mobile devices as tools means that they not only support the flow of the learning activity, but also can function as tools within the activity.*

In the first design, the main device and the slave device were designed to work together as one measuring tool. In the second design, this tool functionality was the same.

The observation that the students divided their focus between devices, teachers and technology personnel, gave the third heuristic, which stated that: *Integrating teachers and technology personnel into mobile activities offer ways to scaffold knowledge and keep learning focused on tasks and not devices*

For the first outdoor activity, the teachers were not instructed to have a role, but intervened when they felt it to be necessary. For the second design, the teachers and the technical personnel were to intervene only when students first approached them. If they were asked a question, they were instructed to encourage the students to find the answer themselves. If none of this worked, the teachers and technical personnel were to answer questions and help out in finding solutions.

Based on an observation that the first design did not use the phones for communication, but left communication outside the devices, the fourth heuristic stated that: *Encouraging face-to-face collaboration and communication makes the learning activity less dependent on the affordances of mobile devices*

Also in the second design all communication was placed outside the devices.

Observing how fluently the students handled the mobile devices, led to the last heuristic stating that: *Building on students' prior knowledge and skills allows students to come prepared and invites them to form their own strategy*

In the preparation work for the outdoor activity of the second design, the students were given two introductory sessions.

3.2 Learning Activities and Tasks

Two introductory activities were used to introduce and let the students practice using the mobile devices, and introduce the outdoor activity and the mobile learning software. In the introduction to the mobile devices, the students were asked to perform tasks such as taking a picture and sending an MMS to practice interacting with buttons and navigation of the phone interface. This activity was held two weeks before the outdoor activity. In the introduction to the outdoor activities, the students were shown a short film from the outdoor activity from the GeM study, they were introduced to the scenario and were invited to go outside and use the devices to measure distances. The introduction to the outdoor activities was held in the week before the outdoor activity. The scenario for the outdoor activity was that an imaginary, almost extinct, spices needed to be relocated from the local wild animal park. The task for the students was to see to that the new enclosures for the animal had the right measurements. Measuring large enclosures required the students to use our mobile software application, which measures the distance between two mobile devices using GPS (Gil and Pettersson, 2010). Apart for measuring, the mobile devices presented students with tasks based on were they were located and where they were in the task structure. The mobile devices were also used for submitting answers, displaying clues and providing feedback.

The outdoor activities started when the students were handed the mobile devices. The "task device" informed them to go to a small field nearby, where they were asked to guess the area of two small rectangles marked by plastic cones. The rectangles had different length and width, but were both 12 m^2. Each group had prepared one 1x1 meters cardboard square to measure the areas. After a completed task they would send the answer to receive a new task. When they had guessed and calculated the areas correctly they received a message on the task device to go to the big field. In the big field they were first asked to guess the area of the large rectangle (4000 m^2) and then to measure the area. The student groups calculated the rectangle by measuring each side of it using the mobile devices and multiplying the two sides. The students' last task was to go to a third field to create their own rectangle with the area 4000 m^2. Through the field tasks there was a progress from measuring small areas with the cardboard square, to measuring large areas with the mobile devices and finally to construct an area.

4. ANALYSIS OF VISUAL FOCUS ON DEVICES

In the analysis of the episodes from the outdoor activity, the students' goals of finding information and reaching the learning goals were related to focus on devices. In the episodes, focus on devices is either present but the students manage to resolve it by using tools provided through the design of the activity, as in Figure 4 and Figure 5, or notably absent, as in Figure 6 and Figure 7.

The 17 episodes were organized into five categories representing the types of focus on devices that occurred in the outdoor activity. We present one episode representative for each of the categories, where the first two episodes are presented in graphical form including the analysis of each interrelation between every component playing a role in the task model analysis.

The names of the participants are replaced with codes. S1-S6 are students, where S1, S2 and S3 are in group 1 and S4, S5 and S6 are in group 2. The personal pronouns she and her are used for both sexes. T1 is a teacher and R1 is a technician.

4.1 Mobile Clue

14 minutes into the activity group 1 searched for information on how to perform a measurement. The group turned their focus from the task device to the clue device for information. The clue showed a short animation on how the measurement could be done (see Figure 3). Once they had watched the clue, they continued with the activity.

Focus on the mobile device occurs in this activity because the information the students need is on the clue device. As soon as they have watched the clue they no longer focus on the mobile device. Group 1 is aware of clues and has used them before in the introductory activity, which allows them to use the clue and then to shift focus and move on. The mobile interaction structures are the same throughout the outdoor activity and therefore they know what to expect.

Figure 4 shows the technological layer of the task model of how group 1 tries to find information on how to perform a measurement. They use a mobile clue, to get the information they need. On the technological layer the subject is group 1, the goal is to find information on how to measure and the tool is a mobile clue. Figure 5 shows the same episode described on the semiotic layer of the task model. The two layers are interrelated.

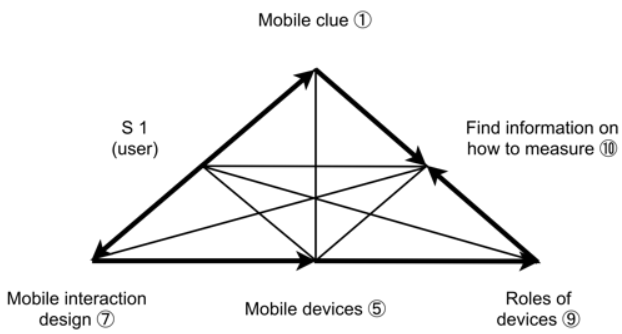

Figure 4: Technological layer of group 1 using a clue

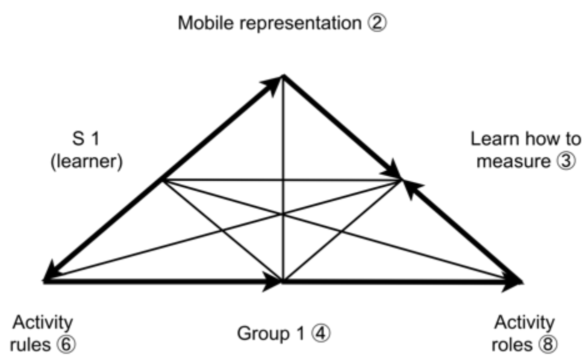

Figure 5: Semiotic layer of group 1 using a clue

Figure 4 and Figure 5 show how S1 is able to contextualize the mobile clue (1) whereby the representation (2) is made available for internalization (3). To be able to do this S1 who uses the task device must involve the group member S2 (4) who uses the clue device (5). To involve S2, S1 must follow the rules of the activity (6), which in this case are given by the mobile interaction design (7). Using their roles (8), given by the roles of the devices (9), the group manages to find the information on how to measure (10). They can thereby learn how to measure (3) and shift focus from the clue device to continue measure the area by using the cardboard square.

In the episode S1 switch focus from the task device to S2, then to the clue device and then on to the task. In doing so S1 switch focus from a digital context to a social context, then to a digital context, on to conceptual context and then on to a physical context (Kukulska-Hulme et al., 2009). At the same time S2 switch focus correspondingly.

The analysis shows that S1 is able to use the mobile clue because of the consistent design of mobile clues (mobile interaction design) and roles of students given by task device and clue device (roles of devices). The components on the technological layer are then interacting with the components on the semiotic layer enabling S1 to learn how to measure. In this episode, the two components on the technological layer *mobile interaction design* and the *roles of devices* are what resolve the focus on the clue device.

4.2 Natural Constraints

43 minutes into the activity S4 was trying place one of the cones on the field for their self-made rectangle. She tried one position and with the help of S5 made a measurement using the mobile devices for measuring. The measurement she received as feedback from the mobile device was too short, which made her move backwards to expand the side of the rectangle. When she reached the edge of the field she noticed this and had to tell the group members that they had to come up with an alternative strategy, which they eventually did and solved the problem that way.

The reason for not focusing on the mobile device in this activity was that S4 used the mobile device for measuring while focused on the natural constraints and the task restrictions. In the design of the activity, the rectangles that could fit into one specific field depended on the natural form of that field. As the activity was designed to use the constraints of the field this absent focus on devices can be referred to the design of the learning activity.

Figure 6 and Figure 7 shows an instantiation of the activity system model similar to the task model.

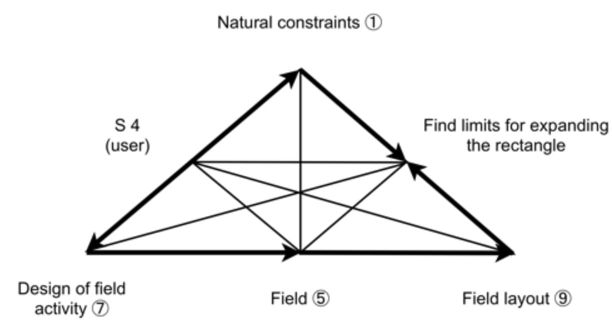

Figure 6: Physical layer of student 4 expanding the rectangle

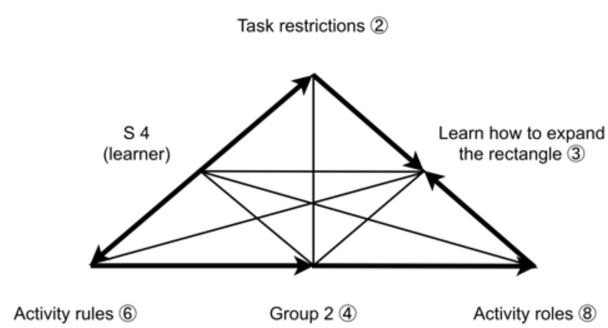

Figure 7: Semiotic layer of student 4 expanding the rectangle

In this instantiation the technological layer in the task model is instead seen as a physical layer (Figure 6). In episodes where the mobile device is conceptualized as a tool the instantiation is identical to the task model, but when other aspects of the activity are identified as tools the instantiation is similar but not identical to the task model. The reason for going beyond the task model is that we describe mobile learning activities in broader sense than Sharples and colleagues (2007), in that both mobile and non-mobile tools are used in the activities we design. This view of how a mobile learning activity can be mediated is still in line with origin of the task model (Engeström, 1987).

The two figures show an episode where S4 tries to expand the self-made rectangle of group 2. When doing this she has to stay within the borders of the field. On the technological layer the subject is S4, the goal is to find limits for expanding the self-made rectangle and the tool is natural constraints. Figure 7 shows the same episode on the semiotic layer.

Figure 6 and Figure 7 show how S4 encounters the edge of the field as natural constraints (labeled "1"), which lets her use the task restrictions (2) on the semiotic layer to learn how to expand the rectangle (3). To learn this S4 also needs help from S5 (4) to measure the increasing distance between their devices at each end of the expanding rectangle (5). The collaboration with S5 is mediated by the rules of the activity (6), which is dependent on the design of the activity (7). Mediating between S5 and the goal is the two roles (8) necessary to perform a measurement, which in turn is related to the layout of the field (9).

The analysis shows that S4 is able to use the natural constraints because of the *design of the field activity* that sets the rules of the activity and the dimensions of the field (*field layout*), which calls for two different roles for the students to perform measurements using the devices.

4.3 Teacher Support

49 minutes into the activity S1 thought that she had locked one of the sides of the rectangle on her mobile device to 2 meters. She was hesitating because she thought that this meant that the final answer would be wrong. This was because the goal to create an area of 4000 m^2 and such a large area would not fit on the field when one side is set to 2 meters. S1 told T1 about her problem and T1 gave her the answer that nothing is locked until they send the final answer. With this S1 could continue measuring the way she was.

In this activity focus on the task device is present because of S1s' current understanding of how a measurement is done. This focus on the device disappears when T1 confirms that nothing is set until they send in the final answer. The reason for this lies in the rules of the activity and the use of the teacher as a tool. The role of the teacher support was to step in when the students have no other way of solving a problem. In this activity T1 steps in when S1 is stuck and has no other option than to go seek teacher support.

4.4 Reference to Introductory Activity

23 minutes into the activity group 2 finished measuring the areas on the small field and started searching for the big field where the task device told them to go. They searched for cones and when S6 asks where to go S5 explicitly refers to a picture of the meadow on the computer. What she means by that is a picture of the meadow that was shown in the introductory activity. Thereby they can draw the conclusion that they are walking in the right direction.

The task model is used to analyze why the group does not focus on the mobile device in this episode. The reason for not focusing on the device in this activity is found to be that they can fall back on prior knowledge, this time knowledge they gained in the introductory activity. This episode shows how the introductory activity, and the whole pedagogical design leading up to the outdoor activity, served to bridge prior knowledge and skills.

4.5 Between Tasks

24 minutes into the activity group 1 finished measuring the areas on the small field and started walking towards the big field. Half way to the big field they put their mobile devices away and started discussing the sequence of subtasks on the small field.

Using the task model, the reason for not focusing on the mobile devices can be interpreted as that they knew what was expected from them. In this observed activity, they use the design of the activity as room for reflection. Group 1 finds room for reflection and uses verbal communication and their externalization of ideas to create common understanding. When they were later asked about why they put their mobile devices away in their pockets, they said that the reasons were that they received the instruction to go to the big field before leaving the small field and that they knew where to go.

5. RESULTS: DESIGN HEURISTICS

The task model has been used to analyze what learning support was needed in the outdoor activity of the second design. The kinds of support needed were also compared to the support that was developed in a design process based on the heuristics from the first design iteration. With this analysis it is time to return to the heuristics.

Using two or more devices with different roles provides implicit roles for students?

We interpret that the mobile clue design was a success in terms of different roles for the devices. In the mobile clue episode the group members switched their focus between devices, the other group members and the task. The focus switches were guided by the design of the learning activity, where the mobile clues were made available to the group on the clue device.

As a side effect of having a separate clue device we could observe collaboration and communication between the students. When the student holding the task device wanted to know about clues, the options available were to ask if there were new clues available and/or walk over to the clue device. We interpret this as the separation of functionality between devices can encourage collaboration between students if interdependence between students is maintained.

⇒ Let students assume roles in the field based on a different functionality of each device

Approaching mobile devices as tools means that they not only support the flow of the learning activity, but also can function as tools within the activity?

Our observations showed that both groups knew how to perform a measurement using the two devices, even the first time they received a task that involved this. When using the two devices as a measuring tool the students did not focus on the devices more than intended.

⇒ Let students use mobile devices as measuring tools

The natural constraints episode also shows the importance of including the physical environment in the design of the mobile learning activities. One simple way of including the physical environment is to, not only require the students to interact with the mobile devices but also to require physical interaction with the environment in the design of the activities.

⇒ Require physical interaction with the environment in the design of the mobile learning activities

Integrating teachers and technology personnel into mobile activities offer ways to scaffold knowledge and keep learning focused on tasks and not devices?

We interpret that throughout the outdoor activity the teacher support did contribute positively to students being able to continue the learning activity. For example in the episodes where students were seeking assistance (as in the episode beginning 49 minutes into the outdoor activity), the teacher support resolved the focus on devices. We also observed episodes where the teachers and the technical personnel took the initiative to intervene, despite that they thereby overstepped restrictive roles they had been assigned. The given instruction was to not intervene unless the students asked them questions. We argue that even more restrictive roles will not solve the problem of teachers wanting to help out. Instead we argue that teachers have to find their roles in relation to technology through the co-design process.

⇒ Let teachers assume roles in the mobile learning activities

Encouraging face-to-face collaboration and communication makes the learning activity less dependent on the affordances of mobile devices?

We did not introduce any communication functionality on the devices between the first and second designs. The implication to place all group communication outside the devices is still valid, when group members are within shouting distance of each other. When the distance between students is greater, phone calls is an alternative when the students know how to use the devices to place a call.

From the analysis we could see one more option on how to encourage face-to-face collaboration. There was one main reason for how group 1 could use the transition to the big field for reflection. The reason was that they knew where they were going and did not have to monitor the devices when going to the big field. From this episode we can see that focus on devices was absent between tasks. Providing space between tasks like this does not mean that the students will collaborate and communicate more, but at least this will give them the possibility to do so.

⇒ Encourage face-to-face collaboration in the mobile learning activities

Building on students' prior knowledge and skills allows students to come prepared and invites them to form their own strategy?

In novel mobile learning activities the mobile devices, the software or the structure of the tasks may be unfamiliar to the students. When the mobile devices are guiding the activities there is a risk of a too strong focus on the devices. The evaluation points to the role of introducing the tools to the students prior to the mobile learning activity. With no introduction of the tools the students will need to appropriate the tools during the mobile learning activity, which leads to a strong focus on the device during this appropriation. A technical introduction and an introduction to the activity can lead to a sought for balance in focusing the educational task at hand.

⇒ Introduce unfamiliar aspects of the mobile learning activity before going into the field

6. DISCUSSION AND FUTURE WORK

Mobile learning opens up for field activities that need to be structured, while still having students in control. This requires that learning theorists and interaction designers develop mobile learning activities where students are able to balance their focus between mobile devices and learning tasks. In this context we analyzed a mobile geometry-learning activity where focus was on devices and where focus on devices was notably absent. The analysis showed that focus on devices could be reduced or resolved by support related either to the design of the mobile devices or to the design of the mobile learning activity or the closely coupled learning activities. The result showed how the support identified could be related to the design heuristics.

The mobile devices should:

- *Let students assume roles*
- *Be used by students as measuring tools*

The mobile learning activities should:

- *Require physical interaction with the environment*
- *Let teachers assume roles*
- *Encourage face-to-face collaboration*

The learning activities should:

- *Introduce unfamiliar aspects of the mobile learning activity before going into the field*

When the focus on one device is too strong the goals of situated learning may not be met because the context for learning is shifted away from the physical environment. Orchestrating this kind of visual focus on devices into the learning scenario is a key factor for experiencing geometric concepts in the physical environment outdoors, with a situated learning perspective.

The contribution of this paper is that it shows how to balance visual focus on devices in mobile learning activities on geometry. The analysis is very much in line with previous results in our iterative design effort. The limitations of the paper are the small number of students participating and to what extent additional teachers in the outdoor and introductory activities match the real world problems.

The problem of balancing focus on devices is not unique to the kind of formal mobile learning activities we study. Instead we argue that focus on devices might be used to guide design for several types of activities where novel devices or device functionality is used. As with all new design there will be aspects of the devices and of the activities that are new to users, why balancing focus on devices continues to be a problem we need to take into account.

In the next iteration of design we plan to use more standard mobile phones and software to address the problem of students not being used to the mobile devices. At the same time we might introduce a new context for balancing focus on devices when we in future design iterations want to make use of augmented reality in the field. For the next design cycle the goal is to keep learners active, where the technical devices are tools in the hands of intelligent users. A goal that is in line with the ambitious aim for ubiquitous computing to create engaging experiences that provoke us to learn, understand, and reflect more upon our interactions with technologies and each other (Rogers, 2006).

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A Mixed Learning Strategy for Pervasive Learning Systems at Workplace

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Abstract

The main topic of this paper is to propose two complementary learning strategies: situation-based and activity-based to fulfill seamless learning across contexts and worked-based learning requirements. In situation-based learning, relevant resources are recommended to the user depending on the current situation. In activity-based learning, the user has to search and to select his/her activities and the corresponding resources. These strategies correspond to two different information dissemination approaches that can be distinguished, namely push and pull (Cheverst, Mitchell, & Davies, 1998). We propose a pervasive learning environment where learners may follow different learning strategies. They may switch from one strategy to the other one according to their needs and/or the context changes. These facilities are possible thanks to a set of models and adaptation processes developed for the P-LearNet project (Pervasive Learning Network). To illustrate this proposal, a use case from this project is used.

Keywords

Pervasive learning, learning at workplace, context-awareness, activity-based learning, situation-based learning, seamless learning.

1. INTRODUCTION

Mobile learning is not just about learning at anytime, at any place and in any form using lightweight devices, but learning in context and seamless learning across different contexts (Balacheff 2006; Sharples 2006; Vavoula and Sharples 2008). It is best viewed as mediating tools in the learning process (Sharples 2006). In mobile learning, TEL (Technology-Enhanced Learning) systems do not have the capability to inquire, detect and explore their environments. In other words, the context is implicit. On the contrary, pervasive and ubiquitous learning systems are context-aware. Many definitions of pervasive learning are given in the literature (Jones and Jo 2004; Bomsdorf 2005; Hundebol and Helms 2006; Thomas 2007). We can cite the following one "Pervasive learning environment is a context (or state) for mediating learning in a physical environment enriched with additional site-specific and situation dependent elements – be it plain data, graphics, information -, knowledge -, and learning objects, or, ultimately, audio-visually enhanced virtual layers" (Hundebol and Helms 2006).

Dey (Dey 2001) defines the context as "any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves". The main idea in this definition-centered application is that the context is the information, which describes the situation of an entity. Hence, a situation is a temporal state in the context. In context-aware applications, situations are external semantic interpretations of low level context used to high-level specification of human behavior and services. Situations inject meaning in the application and are stable and easier to define and maintain than basic contextual data. Adaptations in context-aware applications are then triggered for each change of situation (i.e. a change in a context value triggers the adaptation if the context update modifies the situation). The design and the execution of the applications become much easier with situations since the designer/programmer can operate at a high level of abstraction (situation) rather than all the contextual data, which create the situation. The context consists of a set of structured information. It evolves continuously and is used as interpretation. The nature of information, as well as its interpretation, depends on the goal (Rey 2006). The first issue is to determine the goal and from there, to define the necessary information to serve this goal. Brézillon states that the context is better specified by the current activity of the user: thus, the activity becomes a central notion of the context, it determines the relevant entities: intention, information, knowledge, the objects of the environment, etc., those which are necessary to the achievement of the activity: "the context guides the focus of attention, i.e. the subset of common ground that is pertinent to the current task" (Brézillon 2005). The activity itself is not separated from the context; it belongs to the context as it "guides" the situation of the user (Dourish

2004). The knowledge or the recognition of the activity allows determining in a more precise way the relevant entities of the context. Activities, contexts and learning at workplace are closely related.

At Workplace, learning is centered on work activities in specific situations. Situated learning is able to provide the right learning support at the right time according to the situation parameters and to the goals in the working context. Situated learning increases the quality of learning and is attractive for learning in the workplace and for work-learning integration (Oppermann and Specht 2006). As a consequence, the situation determines relevant activities and the learning needs linked to this activity.

As activities and situations are central issues for learning at workplace, we present two learning strategies (situation-based and activity-based) having the capability to link these issues and to manage pervasive learning issues (provide relevant entities and manage seamless learning across contexts). At workplace, activities can be explicit or implicit, predefined or not in a learning system, but in all these cases they can be realized only in situations or classes of typical situations. Situations and activities are closely linked. Two strategies of learning can be proposed to ensure this connection between situation and activities: one situation-based and the other activity-based. The situation-based learning strategy is used when the intention of the user is not known. It provides on the fly recommendations to an employee according to the current situation. These recommendations consist of relevant entities according to the current situation, i.e. information, documents, services, collaborators, equipment, etc. The activity-based learning strategy is used when an employee explicitly choices a known and predefined activity. We therefore make the assumption that we know the intention of the user that is described by the explicit representation of the activity in the system. This strategy provides to the employees a set of activities, coordinated and organized to support and integrate the learning and working processes. This strategy proposes relevant activities and the right way to carry them out and/or to continue them according to the current situation.

The main contribution of this paper is to propose a mixed learning strategy at workplace that is based on the combination of a situation-based strategy and an activity-based strategy. The main goal of this strategy is to permit learning at workplace in the greatest number of possible situations. Indeed, each of these strategies treats only one part of the problem and only considers some situation classes. This mixed strategy authorizes the consideration of the two sets of situation classes but also their coordination. In other words, it is possible to switch from one strategy to the other but also to ensure continuity and consistency between the two strategies from the history of the situations and the learning and working activities. Thus it ensures seamless learning, i.e. the continuity and the coordination of activities, services and the access to resources.

The paper is organized as follows: firstly, Work-based learning features are described. Situation-based and activity-based learning strategies are presented in section 3 and the mixed strategy in section 4. The section 5 illustrates uses cases extracted from p-learNet project. Finally, the conclusion summarizes the paper after showing how and at which level this framework can be reused.

2. LEARNING AND WORKING

At workplace, learning can occur in purposeful situations in which there is an explicit goal to learn as well as in incidental situations in which there is no explicit learning goal or interest. Working involves an activity or related set of activities that require effort and are aimed at achieving one or more objectives. Learning emphasizes on what a learner knows or is able to do while working is related to performance improvement (Michael-Spector and Wang 2002). In other words, when performing at work, it often happens that learning occurs. The work's performance and quality are also enhanced after learning experiences.

One of the principal characteristics of learning at workplace is to associate theory with practice and knowledge with experiment. However, the traditional model of learning in classrooms separates the theory from the practice and is not always very attractive for learners (Raelin 2008). In general, the learning in classroom stresses on what a learner knows or is able to do while the learning at workplace is related to the improvement of the performance (Michael-Spector and Wang 2002). The needs and the objectives of learning are devoted to competitiveness objectives, productivity and quality, which depend directly on the activities in the company (Drucker 1999). The realization of working activity becomes priority; the learning is only one means to achieve and/or to improve the working activity (Farmer, Lindstaedt et al. 2004). The learning can be done in situations where there are explicit objectives of learning, but also in accidental situations where there is no explicit objective of learning. It is thus sometimes difficult to differentiate the working activities from learning activities.

In work-based learning, two general methods of learning are often used (Pimmer and Gröhbiel 2008): the "just-in-case" and "just-in-time" learning. The "just-in-time" learning brings an immediate value to the working process. It includes the acquisition of knowledge and know-how during the work activity because of its promptness and relevancy. Just-in-time learning might consist of learning by doing and reflecting on the experience. The "just-in-case" learning creates "potential values" for work. It is relevant to use it before or afterwards working activities. It seems interesting to use this kind of learning for a reflection on the working activities and the modification of the working processes. This learning method consists of a reflection on the passed experiments, the generation and the share of new knowledge and the learning with the others. Among the learning activities at workplace, we can mention the following categories: acquisition and revision of knowledge, online helps search, local or remote search. According to the type of the learning method "just-in-time" or "just-in-case" learning, the nature of these activities categories will be different, as they are not submitted to the same constraints.

This need for contextualization and setting in situation of the working and learning activities also can be taken into account by pervasive data processing (Naismith, Lonsdale et al. 2004). Indeed, pervasive computing objectives is to detect and explore the environment, build dynamically models to characterize the current situation and to use these models to adapt the suggested activities, services and contents. It is then possible to associate formal and practical learning, to reach relevant knowledge according to the working activity in which the learning is performed (Pimmer and Gröhbiel 2008).

In conclusion, the learning at workplace is mainly characterized by: i) improvement of the performance and the quality of the working activities and the company; ii) the acquisition of new knowledge and their uses, but also meta-knowledge by thinking about the problem solving processes in the company; iii) business processes and work-learning activities has to be tightly integrated and dedicated to performance. In other words, the integration of knowledge space, workspace and learning space must be done; iv) its close relationship with the working activities and their social contexts in the company. A pervasive learning system should propose to employees' only relevant information, services or activities, according to the situation. Indeed, it is the context and/or the current activity, which determines the requirements in terms for learning in a given community of practices. At workplace, activities and situations, tightly coupled to business processes, are the key issues to design and process work-learning activities. Consequently, situation-based and activity-based learning strategies fulfilling these requirements are relevant in our framework developed in the P-LearNet Project (p-LearNet 2006) which is an exploratory study on adaptive services and usages for human learning in the context of pervasive communication.

In this project, one of our corporate partners is an international retail company having chains of shops and hypermarkets wondering about seller learning in the workplace. Corporate partners identify the problems and requirements about quality and efficiency of information and services to increase market share and the corresponding learning goals. Some learning and working examples are as follows: i) just-in-case learning: a seller equipped with a portable device, for example a PDA or a UMPC, close to shelves (without a customer) can revise their knowledge about products and selling techniques or can continue their previous learning activities to improve their knowledge; ii) Just-in-time learning: during the selling process, the seller can use his/her mobile device as a coach to help him; iii) Just-in-time learning: a seller can communicate with customers while revising his/her knowledge, checking the inventory or contacting the supplier about products. Such type of learning and working support could be done by means of situation-based or activity-based learning strategies and/or the two strategies according to the context changes.

3. SITUATION-BASED AND ACTIVITY-BASED LEARNING STRATEGIES

Learning and working are mainly dedicated to situated working activities, which we want to improve performances. We can break down all employees' activities into three categories: unstructured activities, semi-structured activities and structured activities. These last ones are activities, which we could describe as "procedural". "Procedural" activities have a quite stable structure, can guide the user step by step and determine precise situations of interaction. A structured activity is an activity that can be broken down into sub-activities that are precisely scheduled. The unstructured activities cannot be composed of sub-activities. They are predefined activities that are not well known or are impossible to define as "procedures". Such type of activities mainly provides tools and resources to achieve them without guidance. The semi-structured activities consist of structured activities and unstructured activities. The system can propose a set of predefined activities to the users (structured, unstructured and semi-structured activities). This set is limited and does not take into account all employees' needs because some of activities are not known in advance or the user wants to achieve his activity on its own way. Employees must get entities according to their needs (information, services, activities, collaborators, etc.) to carry out predefined or not predefined activities. A pervasive learning system should only provide relevant entities suitable to the current situation. Indeed, it is the situation and/or the current activity that determines the requirements in terms of learning and working in a given community of practices. The activities can be explicit or implicit, predefined or not, but in all cases they can only be achieved in a particular situation or in typical situation classes. The situation and the activities are closely dependant.

Two learning strategies can be proposed to ensure this connection between situation and activities: situation-based strategy and activity-based strategy. The situation-based strategy provides recommendations to the employee according to the current situation. It proposes relevant entities according to the current situation (i.e. information, services, predefined activities, collaborators, equipment, etc.) in push or pull mode (Cheverst, Mitchell et al. 1998). In the push mode, the system is proactive that means it decides when the employee is notified according to the situation changes. In other words, the system proposes automatically recommendations depending on the situation changes without any human intervention. Thus, an employee can select or not one of the given recommendations. However, in the pull mode, an employee searches himself for information. Thus, the employees "write queries" to express their specific needs to obtain the relevant entities according to the current situation.

The activity-based strategy is used as soon as an employee selects a predefined activity. The activity-based strategy provides a set of predefined activities integrating the learning and working processes to the employees. When an employee explicitly chooses an activity, the activity-based approach determines the right ways to execute the activity according to the current situation. Moreover it also ensures the orchestration of the sub-activities for the structured or semi-structured activities. Otherwise, it only provides relevant resources and tools to achieve activity

These two approaches are now presented by specifying their characteristics as well as their advantages and drawbacks. Then we present the mixed approach that combines these two approaches.

3.1 Situation-based Learning

The situation-based learning is an approach in which the situation of the employee is in the core of the learning. The situation serves either to detect learning needs by analyzing the current situation, or to represent the situated knowledge during work and to react to each change of situation of the employees.

The situations management in reactive systems needs to define a situation. To be able to detect situations, key information must be included in the definition of the situation: i) the events which can take part in the detection of situation; ii) the context in which the detection of situation is suitable; iii) the semantic conditions which must be satisfactory in order to detect a situation;

In our case, we distinguish two functioning modes (see figure 1): the push and pull modes. In the push mode, the strategy of learning based on the situations is activated with the arrival of a new event that modifies the current context of learning (Bouzeghoub, Defude et al. 2006; Bouzeghoub and Do 2008; Bouzeghoub, Do et al. 2008; Bouzeghoub and Do 2009; Bouzeghoub and Do 2010). It is also called system-oriented approach because the system controls the recommendation of entities. A situation is a subset of properties accessible from the context at a given moment. The environment must adapt the process of learning and working to this new situation. The context adaptation mechanism of the learning processes is divided into two parts: i) the current situation is recognized and identified among the set of the predefined situations and the corresponding adaptation rules are applied to propose recommendations. For example, the employee encounters difficulties and needs assistance and an author/designer has predefined the relevant actions for this help: to provide a resource and/or a simpler and more detailed activity or to propose the assistance of an expert (instructor) or a colleague which are connected; ii) the current situation is not recognized. A mechanism of case-based reasoning is used to find a prototypic situation similar from which similar recommendations will be proposed. According to the number of resources and/or activities suggested, two processes of filtering can be used to reduce the number of recommendations according to knowledge and know-how and preferences to the employee.

In the pull mode, the user starts the process with a query. The result of the query is then adapted to the situation of the user and then filtered according to his knowledge and his preferences.

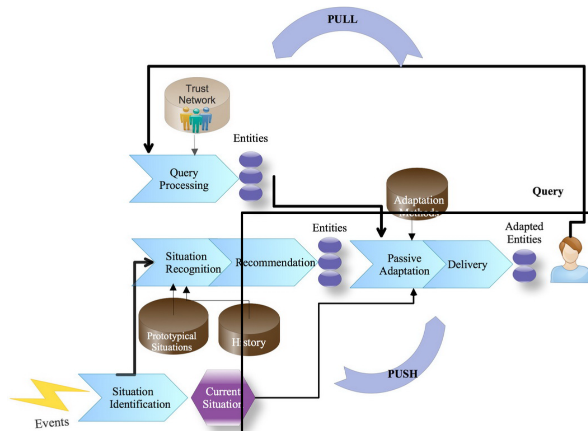

Figure 1. The situation-based learning strategy

The seamless learning is managed at two levels: at learning object level and at domain concept level. After a change of situation, the system can propose to an employee to continue his "activity" in the new situation with the same learning objects if it is possible or with an equivalent one according to this new situation. The system may also propose the same entities or new entities to the employee allowing him to continue a knowledge acquisition on the same concepts.

This strategy offers the following advantages: i) it proposes two interaction modes, the push mode in which the system takes the control and guides the employee in his training according to his current situation and the pull mode where the employee controls his learning path by choosing himself the learning entities that he wants to use; ii) A recommendation system is started for each arrival of a new event. It proposes on the fly learning resources, equipments or collaborators according to the new situation; iii) Finally, this strategy generates links between employee's activities and social context by proposing collaborators in the geographical neighbourhood, having the same profile, doing the same activity or having already seen the same problem.

Among the drawbacks, we can mention: i) the lack of scenario as support for learning make difficult the check of consistency. Indeed, the fact that the employee follows a free learning by choosing himself his path does not allow consistency checking; ii) the intention of the employee is not known a priori.

The next section presents the activity-based strategy, which is complementary to situation-based strategy. The situation-based strategy is used when the employee's activity is not known or when the employee wants to achieve it in its own way (without guidance) or when the activity-based strategy is unable to provide relevant predefined activities according to the current situation. When an employee is willing to achieve a predefined activity and the activity-based strategy is able to provide a relevant one, the activity-based strategy can be used.

3.2 Activity-Based Learning

Activity-based learning strategy provides a set of activities to learners where activities and sub-activities are explicitly represented, structured and coordinated to support business and learning integrated processes (Pham-Nguyen and Garlatti 2008; Pham-Nguyen and Garlatti 2008; Pham-Nguyen, Lau et al. 2008; Pham-Nguyen, Garlatti et al. 2009; Pham-Nguyen, Garlatti et al. 2009). When the learner explicitly chooses an activity, several ways for achieving it are proposed according to the current context. In our framework, an activity is represented by task by means of a hierarchical task model, having the task/method paradigm. There are two types of tasks: abstract tasks and atomic tasks. An abstract task can be composed of atomic and abstract sub-tasks. An atomic task cannot be composed of sub-tasks. It consists of a simple procedure or function. Several methods can be associated to a task. A method represents a way to perform a task in a class of situations. It determines how to break down a task into sub-tasks and how to define their coordination. A method, associated to an abstract task, defines a control structure, which determines the task coordination, that is to say the recursive decomposition of tasks into sub-tasks (by means of operators) and the sub-task order at runtime.

A structured or semi-structured activity is represented by an abstract task, which is broken down into abstract sub-tasks and atomic sub-tasks. An unstructured activity is represented by an atomic task providing tools and environments necessary to achieve the corresponding activity. In such a case, the activity is not controlled or guided by the system (hierarchical task model). In Activity-based Learning, the goal of generic scenarios is to describe the learning and working integrated activities to acquire some knowledge domain and know-how to solve a particular problem or to support working activities. An author/designer can manage a global activity consistency in a generic scenario. A generic scenario consists of an abstract task broken down into sub-tasks through methods. This abstract task is composed of a set of pairs (task, method) that represent the greatest number of learning and working situations for each abstract task. The context-aware and adaptive mechanism can be viewed as the selection of the relevant pair (task, methods) for a given task according to the current working and/or learning situation. Thus, at runtime, the adaptive mechanism chooses at least one pair (task, method) for a given task according to the current situation. The seamless learning and working strategy is based on generic scenarios.

Contrary to the situation-based strategy, there is only one mode available for the activity-based strategy, that is to say the push mode (see figure 2). The adaptive mechanism selects the relevant pairs (task, method) according to the current situation. This mechanism is based on a matching between the contextual description of methods and the features of the current situation.

Figure 2. The activity-based learning strategy

For each new event (push mode), the new situation is identified and the system gathers potential activities - pairs (task/method) - which are filtered by the adaptive mechanism according to the new situation. The adaptation mechanism is based on two integrated and ordered strategies: 1) by reflexivity 2) by contract (Chaari 2007). The idea is to use metadata associated to context properties (reflexivity) and rules (by contract) to deal with the dynamic feature of context (in a given situation, you cannot ensure that all context properties are available). For properties managed by reflexivity, the first adaptation mechanism filters out the non-relevant pairs (task, method). For others properties (managed by contract), rules are applied to classify the pairs (task, method) in equivalence classes. This second adaptation mechanism is strongly constrained in comparison with the situation-based strategy mechanism. The corresponding matching process is based on necessary and sufficient conditions to belong to an equivalence class defined by a conjunction of properties (at least two equivalence classes, "good" and "bad", mutually exclusive). Thus, sometimes all properties involved in the matching process are not available. Sometimes, it could be impossible to select a relevant activity. The adaptation mechanism provides to an employee all relevant activities and how to achieve them - pair (task, method). It can propose to continue the current activity, to take up suspended activities or to begin new activities. The employee is in charge to choose an activity - select a pair (task, method), to change the current activity and to finish an activity.

The seamless learning and working is managed as follows: i) a generic scenario enable an author/designer to define a global and consistent organization of an activity set across contexts and their coordination; ii) the adaptation mechanism is able to managed suspended activities after situation changes. The states associated to pair (task, method) are used to take up suspended activities and/or to continue the following activity according to the coordination of the sub-tasks of a particular pair (task, method); iii) A competence model, based on knowledge and know-how, is used to ensure the continuity of the learning process across contexts. It is necessary to be able to evaluate the employee levels of knowledge and know-how based on their performance and working quality. In other words, the adaptation mechanism has to provide the relevant pairs (task, method) according to the current levels of knowledge and know-how of an employee to ensure gradual learning and working.

The main advantages of the activity-based learning strategies are as follows: i) generic scenarios enable us to ensure global consistency of activities across contexts and provide a relevant integration of learning and working activities; ii) as structured activities are well known, one can ensure a continuous learning process across contexts by means of the states associated to the pairs (task, method) and the competence model.

The main drawbacks are as follows: i) all activities and situations of employees cannot be represented because some of them are not known or employees do not want to use a modelled activity; ii) as the adaptation mechanism is constrained, sometimes the system is unable to provide relevant activities. The system can be unable to support the employee working activities; iii) collaborative working and learning activities are not explicitly represented. These activities are important for learning at workplace.

The mixed strategy, proposed in this paper, aims at eliminating the drawbacks of the situation-based and activity-based strategies. The main idea is to deal with the greatest number of learning and working situations for employees.

4. MIXED STRATEGY

The mixed strategy combines the two learning strategies: situation-based and activity-based learning strategies. In this paragraph we will show how and when the two strategies are activated and how they are complementary. In other words, we will on the one hand define the conditions of transition from one strategy to another for the two modes push and pull and on the other hand list the contributions of the mixed strategy in term of seamless learning.

The mixed strategy life cycle modifies and integrates the two previous strategies life cycles. We will describe on the one hand the two strategies in push and pull mode and on the other hand the conditions of transition from each strategy to the other. For each strategy, new functionalities are proposed: i) the pull mode is now available for the activity-based strategy; ii) the situation-based strategy can also propose activities in the two modes.

The situation-based strategy is activated by default in pull or push mode because it proposes more entities whatever the mode. When an employee writes a query on entities, the situation-based strategy is automatically activated in pull mode. The suggested entities can be contents, Web services, collaborators, predefined activities, etc. The system provides as a result a list of potential entities, which are then filtered by the adaptation mechanism (of the situation-based strategy) to keep only those, which are relevant in the current situation. Then, they are delivered to the employee.

The employee can also choose to be in the push mode. In this case, the system proposes him relevant entities (including activities) according to its current situation and starts again this process of recommendation at each time an event changes the current situation and generates a new situation.

The transition from this strategy to the activity-based strategy is done as soon as an employee selects an activity, in push or pull mode. In pull mode, the user may continue to achieve the selected activity as long as the current situation is suitable. If it is not the case, he can choose either to write a new query in pull mode or to pass in push mode to obtain automatically suggested entities. In pull mode, the system does not move itself to the situation-based strategy. It can only be the result of the employee intervention. In push mode, the system proposes to him relevant activities according to its current situation and starts again this process at each time an event changes the current situation and generates a new situation. If the employee chooses an activity, the process is the same as previously described for the activity-based strategy. The system can thus propose to continue interrupted activities or to begin new activities.

The system switches from activity-based strategy to situation-based strategy if the employee does not wish to use the suggested activities or if the activity-based strategy cannot propose activities any more. Indeed, the situation-based strategy is less constrained in terms of filtering and will be able to propose more activities and/or entities “semantically” related to the interrupted activity or entities already reached in similar situations. In this case, the system is never in a blocked situation and may always suggest an entity. The system changes its mode to deal with the drawbacks of the activity-based strategy.

5. USE CASES

Among the scenarios studied in the project, we are interested here in the postman scenario to illustrate the problems of the learning at work and to need to mix a situation-based strategy and activity-based strategy.

In his daily mission, each postman has a mobile terminal, which enables him to interact with a knowledge base (e.g. query mode via a Web interface) and with a group of colleagues (e.g. standard Web interface). With each access, the terminal transmits data of geo-localization. The terminal is also equipped with an integrated camera. Confronted with a difficulty in its mission, the postman can:

1) Ask the knowledge base: This action is done in query mode (or pull mode) with a Web form. The postman profits from all the descriptions done by his/her colleagues as well as official indications. A postman starting a new round can thus see whether particular cases were previously announced. He can also consult a procedure or search for an activity. We recognize in this example a "just-in-case" learning that is supported by the situation-based strategy. If the postman chooses an activity, the system switches to the activity-based strategy.

2) Be informed in real time: This application implies that the postman has activated the option "free path". This option allows a permanent follow-up of the postman trajectory and can be useful for safety reasons (in countryside, transported funds, etc.) This option notifies in real time (e.g. SMS, etc.), that the place where he will pass was the subject of an important remark classified by one of his/her colleagues previously in charge of this round. If the postman encounters a difficulty in the task which he is achieving, the application indicates to him (i) one or more colleague(s) having already made this round or a correspondent of a support service who are currently connected (ii) a reference to a related course (iii) a linked activity allowing him to review the procedures to be followed. This example illustrates a "just-in-time" learning supported by the situation-based learning strategy with push mode.

3) Work during his free time or when he is not on his round: the application also enables postmen to work out of work hours to look further into a concept. This is another example of "just-in-case" learning supported by the situation-based learning strategy with pull mode.

These examples show various types of learning at workplace in real contexts. They highlight the need of several types of learning for the same learner and the importance of switching from one strategy to another to guarantee seamless features.

6. CONCLUSION

We proposed a framework managing and mixing situation-based and activity-based learning strategies. This approach enables us to fulfill seamless learning across contexts at workplace and has been tested in the P-LearNet project.

To summarize, the main issue of the paper is to show how two learning strategies work together in order to achieve a common goal: provide to learner the most relevant resources (activity, course, document, etc.) at the right moment depending on his/her context. In particular, we will show how learning processes, performed by switching from one learning strategy to another, ensure seamless learning across contexts.

The mixed learning strategy takes advantage of the two learning and working strategies. The switch from one strategy to the other is done (i) either explicitly by the user with choosing an activity or following a free course guided by the system. In this last case, recommendations of entities are proposed when necessary according to his current situation; (ii) or automatically after an interruption of the execution of the activity in progress; in this case the system analyzes the current situation of the user and recommends an entity in the continuity of the interrupted activity.

One of the most important challenges of the project was to deal with the change of company practices. In other words, as soon as you change activities by introducing new tools, you also change activity and role distribution in the company. Moreover, employees, involved in the project, are under the pressure of everyday activities. Thus, it is difficult to involve all required services in the experiments and consequently they are limited. "Just-in-time" and "just-in-time" learning are not easy to acquire and to design. The first one could be used during everyday activities as soon as employees are unable to deal with the current activity. It is necessary to help employees without disturbing them too much. Productivity should be enhanced because without help, they are unable to deal with the activity. "Just-in-case" learning requires that employees have enough time to reflect on past activities and to acquire new knowledge, which is not obvious in most of the companies.

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How students in Higher Education use their mobile phones for learning

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Abstract

This paper reports on a project that is conducting empirical research to find out how students in Higher Education are using their mobile phones for learning. Data of student mobile phone ownership and their attitude to using their mobiles for learning has been gathered through a student survey. This has been followed-up with in-depth studies with a smaller number of students. The paper presents the results from the survey, and 3 in-depth case studies of why and how students are using their mobiles for learning. Such research gives valuable insights into students' practice and attitudes towards mobile learning, helping us to design effective mobile learning activities that capitalise on what they already do, and can potentially do with their mobile phones.

Keywords

Mobile learning, students' mobile phones, Higher Education

1. INTRODUCTION

It is now accepted that mobile devices have a number of important characteristics which make them attractive from an educational perspective, including increasing portability, functionality, multimedia convergence, ubiquity, personal ownership, social interactivity, context sensitivity, location awareness, connectivity and personalisation (Pachler et al, 2010). And much research has taken place documenting mlearning pilots and projects, and in developing theoretical frameworks to scaffold mobile learning (e.g. Kukulska-Hulme et al, 2009; Laurillard, 2007). However, there is a lack of research into how students are actually using their own phones for learning outside of the formal classroom.

This paper presents initial results from a small project funded at London Metropolitan University (London Met) to explore in depth how students are using their mobile phones to help with their learning. London Met is an inner-city University which encourages widening participation. As a result, the student body is diverse: there are many mature learners (many with children) who are returning to education and international students who do not speak English as their first language. Most students also now work to fund their studies. Hence tutors are actively seeking strategies to engage learners both inside and outside the classroom. For the project, initial data was gathered from a student survey of mobile phone use. This was followed-up with in-depth studies with a smaller number of students to obtain a greater understanding about student practice and their attitudes towards mobile learning. Three students were loaned Flip Video camcorders to record their daily use of their phone for learning activities. Afterwards, they each participated in a follow-up interview. This has resulted in 3 case studies of student-initiated mobile learning, which provides much insight into the functions of their mobiles that they use, and the types of learning activities that they use them for. More importantly, they help us to understand students' attitudes towards using their mobiles as a tool for learning. The 'Learning on the move' website contains all the outcomes from the project, including the survey results, student videos and case studies [www.londonmet.ac.uk/learningonthemove/index.html].

2. BACKGROUND

To put this current work into perspective, the authors of this paper have been involved in a number of mobile learning initiatives and pilot projects at the university over the past few years. These include: a student mobile phone survey conducted over 5 years; lending mobile phones to MA students to complete an out-of-classroom assignment, which included the provision of a phone-based checklist to remind them of their task; the provision of an online 'mediaBoard' for students to post images and discuss their groupwork in support of a field trip and assignment (Cook et al, 2006); the provision of study tips via SMS; the creation of learning objects for mobiles (Bradley et al, 2009); and the use of TXT messages in lectures to increase student participation and engagement (Bradley et al, 2010).

Much of our work aims to understand and improve the learning experience and help a diverse body of students to succeed at University. Evaluations and lessons learned from previous work, has shown that students are motivated to use new technologies (and in particular mobile phones) for learning activities, and that carefully designed mobile learning activities can engage students to participate in them (Bradley et al, 2010; Bradley, Smith & Cook, 2010). Once engaged within the learning process, they can be motivated to participate and stay engaged. We know from our student survey conducted over the last 5 years that all students now own a mobile phone, and that the phones they have are increasingly sophisticated (Bradley and Holley, 2010). It also tells us that students are open to the idea of anytime, anywhere learning, that enables them to schedule their own learning within their busy lives, whenever and wherever it is most appropriate.

This research stems from the desire to be able to utilise the powerful mobile phones that students now have with them all the time - devices which they know how to use, and already use for a multitude of tasks in their everyday lives. We agree with Schuck et al, that given the ubiquity of mobile devices, an imperative has arisen for educators in Higher Education to familiarise themselves with the affordances of mobile technologies for learning so that they are able to capitalise on their students' usage of these devices for effective learning (Schuck et al, 2010). Future projects can utilise students' own technology, avoiding the need for the University to provide it and thus a whole set of operational issues (cost, training, support, adoption of use etc.) which many earlier projects experienced. However, we first need an understanding of students' attitudes to and their uses of their mobiles for learning before we can design effective mobile learning activities that will bring mobile phones into the blended learning arena, including them within learning scenarios, rather than excluding them.

The next section presents the results from our student mobile learning survey. This is then followed by the three case studies of student mobile phone use. In the final Discussion and conclusions section we discuss the findings and key emerging issues, and the implications of them on our future work.

3. SURVEY RESULTS: STUDENT MOBILE PHONES AND THEIR USE

The first stage of the research was to conduct a survey with students to find out what mobile phones they have, what their attitudes are towards using them for learning, and what they actually use them for. A short paper-based questionnaire was given to first-year students taking a core business module, 'Studying Marketing and Operations'. The results are presented in this section.

3.1 The students and their mobile phones

74 students completed the questionnaire. All 74 students own a mobile phone. 73% of the students were female, 28% male. Table 1 shows their age profile.

Table 1: Age profile of students

Age range	18-20	21-25	25-30	30-35
% respondents	61%	33%	5%	1%

No students were aged over 35, and the majority 61% was 18-20, with another 33% aged between 21 and 25. The gender and age characteristics reflect the average make-up of the module cohort, being predominantly female and in their late teens/early twenties (a significant number of fashion marketing students study this module).

63% of students have their phone on a monthly contract, and the other 37% use 'pay as you go' (PAYG). Contracts usually provide inclusive call-time, SMS messages and data download. The implication is that if students have these included within their monthly tariff, they will be less concerned about the costs incurred of using their phone (financial concerns are common amongst our students).

Table 2 shows how long students are likely to keep each handset for. This provides a measure of how frequently new devices are acquired, each one generally having greater functionality than the previous one.

Table 2: Length of time students keep a phone for

Time period	6 months	12 months	18 months	As long as possible
% respondents	1%	37%	27%	35%

37% keep their phone for 12 months, but 35% like to keep their phone for 'as long as possible'. 27% keep a phone for 18 months (the current average length of a contract).

The range of handsets owned by the students is diverse: 72 students cited 37 phone models from 9 manufactures (1 student had 2 handsets and several did not specify a precise model). 23 students owned 10 specified Nokia models; 14 owned 5 Blackberry models; 14 owned 9 Sony Ericsson models; 9 owned 3 Samsung models; 6 owned 2 Apple iPhone models; 6 owned 5 LG models; one student each owned an HTC, T-Mobile and a Vodaphone. About 80% of these handsets can be classified as Smart Phones (where this can be determined from the model information supplied, as some don't specify precisely what they have). Whilst there is not an industry standard definition of a Smart Phone, we have taken this to mean a high-end phone that includes web browsing and email. Figure 1 below shows the phones that students own by make, with the number of Smart phones indicated.

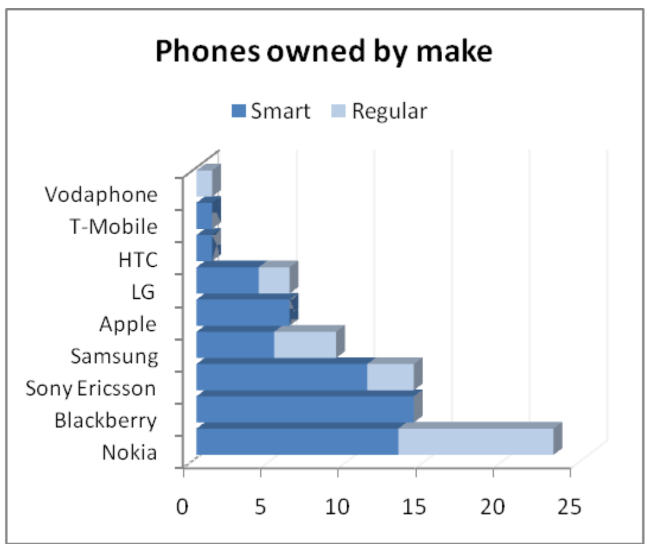

Figure 1: Phones owned by make

This data is important, as it shows the diverse range of phones that would have to be supported in any mobile learning initiatives.

The real indicator of what students can do with their phones is shown in Figure 2, features of students' mobile phones.

Colour screens are now standard for 97% of the students. The ability to be able to capture and generate content is also a possibility for a high proportion of students: 96% have a camera, 86% can record video and 84% can record audio/voice. The ability to access data networks and share data is also becoming more commonplace: 80% of students can access the Internet from their mobiles, 50% can access WIFI, 91% have Bluetooth, 46% 3G and 50% GPS. WIFI is important as it enables students to have free access to the Internet and other data sources where a freely-available WIFI network is available.

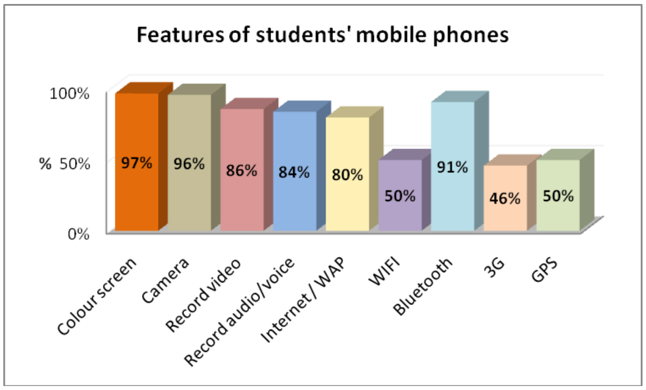

Figure 2: Features of students' mobile phones

3.2 Students' attitudes to using their phones for learning

Three questions were asked about their attitudes to using their mobile phone for learning and being contacted by the University. The results to these questions are discussed in the 'Discussion and Conclusion' section, as insights from the students interviewed help us to better understand the student viewpoint. Table 3 shows the responses to the question 'How much is the ability to learn at any time and in any place important to you?' which was designed to find out about their attitude towards flexible learning, and therefore potentially mobile learning.

Table 3: How much is the ability to learn at any time and in any place important to you?

Extremely important	1	2	3	4	5	Not at all important
% respondents	30	26	29	4	5	

Adding the results at the positive and negative ends of the scale together (1 + 2 and 4 + 5) makes it easier to interpret the results. 56% think it is important to be able to learn at any time and in any place, 29% are unsure (choosing '3' in the middle), and only 9% think it isn't important.

Table 4 explores the question 'How useful would it be to access learning materials via your mobile?', as earlier research explored developing learning objects for mobiles.

Table 4: How useful would it be to access learning materials via your mobile?

Extremely useful	1	2	3	4	5	Not at all useful
% respondents	29	30	16	12	13	

59% think it would be useful to access learning materials from their mobile, 25% think it wouldn't be useful, and 16% are unsure.

Figure 4 shows the responses to the question 'How would you view the university contacting you via your mobile for learning purposes?' which aimed to find out how 'personal' students viewed their mobiles and whether such activities were seen to be intrusive.

Table 5: How would you view the university contacting you via your mobile for learning purposes?

It would be a positive aspect	1	2	3	4	5	It would be a negative aspect
% respondents	26	24	29	10.5	10.5	

50% gave a positive view, 29% are unsure and 21% have a negative view, so student opinion is divided on this issue.

3.3 How students use their mobile phones for learning

The final question was 'Do you currently use your mobile phone to help with your learning, and if so, what do you use it for?'

22 students (29%) reported using their mobiles for learning, citing 34 different uses. These uses have been grouped into 7 categories in the table below: conducting research/getting information, communicating, generating content/artefacts, using tools/applications, organising, notetaking and 'other'.

Table 6: How students use their mobile phones to help with their learning

Category and mobile phone use	Total uses
Conducting research / getting information	**12**
Internet (4 students)	
Google (3 students)	
Research (2 students)	
Researching on the Internet	
Accessing info pages	
Search information	
Communicating	**6**
Email (2 students)	
Saving emails	
To receive emails	
Contacting group assignment members	
Fashion Facebook group	
Generating content / artefacts	**4**
Take pictures/photos (2 students)	
Take pictures of artworks	
Voice recording	

Using tools /applications	4
Calculator (3 students)	
Microsoft Office	
Organising	**3**
Organiser	
Check my exams	
Putting reminder alarms for meetings	
Notetaking	**1**
Write notes	
Other	**4**
Accessing learning materials	
Presentations	
Record presentations	
Transport files (PDF, Word, Powerpoint …)	

The most common category of use was 'conducting research and getting information', cited by 12 students. Of these, 10 involved using the Internet, and 2 simply cited 'research' which probably meant using the Internet. Data from the last 3 years of our survey (since the question about mobile learning use was introduced) shows that use of the Internet for research has increased the most, and has overtaken communication with this year's students (Bradley and Holley, 2010). The 'communicating' category saw the next highest number of instances, with 6 uses: 4 used email and 2 others used their mobile to keep in contact with other students (one via Facebook). Interestingly, no students mentioned using text messaging. 4 students used their mobile for 'generating content/artefacts', 3 for taking pictures or photos and 1 for voice recording. In the 'using tools and applications' category, 3 used the calculator and 1 Microsoft Office. The use of Microsoft Office is interesting here, as for this student their mobile phone is clearly taking over some of the functionality of their PC (this student owned a Blackberry Curve). 3 students used their mobile for organising their studying, citing using the organiser, checking exams, and setting reminder alarms for meetings. One use was registered in the 'notetaking' category. Four 'other' uses were cited: accessing learning materials, presentations, record presentations and transport files.

4. CASE STUDIES OF STUDENT MOBILE PHONE USE FOR LEARNING

The second stage of the research was to lend 3 students Flip Video camcorders so that they could capture their mobile learning activities. Afterwards, students were interviewed, to further explore their practice, and they also completed the questionnaire so that we had the same background information as the other students. From the video footage and information provided in the interview, a case study has been compiled for each student, illustrating their mobile learning activity, and attitude towards it.

4.1 Case study 1: Sam

Sam is a first-year student at London Met, studying Foundation art, media and design. He is male, between 18 to 20 years old, and has a Blackberry Curve, which he has only owned for about 2 weeks (previously he had a Sony Ericsson which was a hand-me-down). He has his mobile on an 18-month contract, which gives him unlimited Internet access and a large amount of inclusive call time and texts. He has not been involved in any mobile learning activities during his first year at the University, saying "if I have used it, it would have been something that I just wanted to do, not advised to do".

He uses his phone for the following learning activities:

- Setting reminders in the calendar and using the clock and alarm to help organise his studying and his schedule.
- Using the camera to capture images and notices and things to remember when he's at art galleries and exhibitions. These are mainly for reference so he can browse through them at his leisure, and he may go back and take higher quality photos with his camera to use in his course notebook or for coursework (he doesn't consider the camera on the Blackberry to be of sufficient quality).
- Using the voice recording to record lectures, if he thinks it will be important, so he can replay it later.
- Communicating with other students, mainly via phone calls as he has a lot of free call time. He also uses Blackberry Messenger to communicate with other students with Blackberry's, as this is free.
- Using the Internet and Google to look up necessary information.

His most common use is "probably the calendar, because that is really useful, because my organisational skills aren't very good, so it does help to have a little buzz when you need to do something".

He doesn't use his mobile for writing notes, apart from entering dates into the calendar to set reminders for things he needs to do: "I just write a brief line in the calendar saying I need to do this by that date." However, now he has a Blackberry, he could see himself using it to take notes in the future, because it has a full alphabetic keypad, unlike the limited keypad on his previous phone. "Yeah, I could definitely see myself using it for notes in the future." He doesn't use it at the moment because he's usually got pen and paper and it's easier to use that.

On a daily basis, he uses his phone most for calling people, as he has lots of inclusive minutes. He also uses Blackberry Messenger, and plays games when he's sitting on a train or somewhere.

He uses his mobile to help with learning because it is "convenient". "Because it's convenient, I mean I've got it in my pocket 24 hours a day, it's always there, and now I can use the Internet … it's just convenient." He uses his mobile for learning "when necessary" (he thinks that the ability to learn at any time and in any place is important). He probably engages in mobile learning once or twice a day on the days when he's at the University (about 3 or 4 days a week), and less on days where he's not there. Regarding the location of most of his mobile learning activities, he tends to carry out activities at gallery visits and exhibitions, during lectures for recording them or entering information such as dates and deadlines into the calendar, and at home, for checking notifications of forthcoming deadlines, tasks etc. to see what he has to do and bases his homework around the deadlines. He tends to drive into University, and therefore doesn't use his mobile whilst travelling.

He knows that many of his fellow students also use their mobiles for learning (he wasn't able to give a percentage), and said that the numbers were increasing because mobile technology and the phones that they have are becoming more sophisticated, saying you can do much more now than even last year. However he acknowledged that people are different and how much they used their mobile would depend on what phone they'd got. About half the students have a Blackberry, partly because it's free to do Blackberry to Blackberry messaging and you can access Facebook from it too. He also believes that mobile phones are no longer just for calling and texting, and have become a fashion accessory, and that everyone wants to have the latest phone. He reckons that he uses his phone more now than other students (because he's just got the new, more sophisticated one). As an example, he mentioned that one student listens to music on his phone when he draws to help him concentrate. He thinks that all the students on his course will have used their mobiles at least once during the year for learning purposes.

When asked if the University could do anything to make it easier to engage in mobile learning, he said maybe send texts about deadlines as reminders, such as "have you done the work, do you need any help, if so contact this number".

4.2 Case study 2: Shriya

Shriya is a first-year International student from India, studying Event Management and Public Relations. She is female, aged between 18 to 20, and has a Blackberry Curve which she has had for about 2 months. She uses 'Pay as you go' and pays £5 per month for unlimited Internet access. She has not been involved in any mobile learning activities this year at the University, but she did experience mobile learning on a previous short course, 'Photography and personal styling' at the London College of Fashion. During that, the tutor encouraged them to use their phones to take photographs and exchange ideas. Everyone was very enthusiastic to use their mobiles, and it was because of this course that she bought a good mobile phone (she wasn't interested in them previously because she didn't realise the benefits). She also realised that using mobile phones in such a situation had the power to "hook" you into the learning activities.

She bought a Blackberry because it is equipped with all the Windows software. She has an Apple MacBook laptop, and finds it difficult to connect with some of the University systems (such as Webmail, the email system), whereas on her Blackberry, she has no problems and can access anything she wants. She said "I'm forced to use my phone as my main source of communication." She has started to use her Blackberry for so much now, that it has overtaken the use of her laptop.

Having the ability to learn at any time and in any place is important to her, and her Blackberry facilitates this. She thinks it's extremely important be to be able to access learning materials via her mobile. She believes that students are used to their phones and because they can now do such things, it is important. She also thinks it would be positive for the University to contact her on her mobile for learning purposes. Sending messages to her mobile would be a faster process of communication, and she wouldn't object to what the university contacted her about, as long as it wasn't in the middle of the night.

She uses her phone for the following learning activities:

- To access email. Her email accounts forward to her mobile, so emails go straight to her phone, "so you don't need a laptop to sign in and it's best when you don't have access to the net".
- Communicate with classmates, via the Blackberry Messenger (which is free amongst Blackberry users) and chat, because these are free forms of communication for her. Using this she can chat, send files and pictures and share documents for free.
- To download materials from WebLearn (London Met's VLE).
- To access Facebook. One of her tutorial groups set up a Facebook group before Easter to facilitate the exchange of work and ideas for a group project. Over the Easter holidays, many of the students travelled abroad, and 3 of them were unable to fly back to the UK in time for the completion of the project because of the Volcanic ash cloud affecting European airspace. The group was therefore able to continue with the project, and those unable to be physically present at the University were able to participate through their participation in the Facebook group. What was started as a means of communicating turned into a "life-saver" for these students.
- Access University systems, e.g. Webmail (the email system) and Evision (the student record system). As she can't access her university email from her laptop, her mobile has become the only means for accessing email now.
- She makes notes using the 'Memopad' in which you can write quick notes and attach alarms to give reminders, which can also link through to the calendar. She also uses 'Word to go' which is Blackberry's cut-down version of Microsoft Word to write reports. She will start typing up notes in lectures, and then use these as the basis of her notes and reports. These files can then be emailed, or submitted as coursework.

Her most common daily use of her phone is for Facebook, followed by Messenger which she described as a "lifesaver". For learning, she uses it most for emailing tutors and writing reports.

She uses her phone for learning because it is easier, it is accessible (always connected to the Internet and other people), you can use it anywhere and everywhere, and you don't have to carry a heavy laptop around with you. She said "it really helps you because it saves on time and money". She estimates using her phone for learning about 3-4 times a week, totaling about 20 hours.

She generally carries out her mobile learning activities in quiet places: in her room, in the park around the corner, but not in the library, because they don't allow the use of mobile phones (although a lot of students do use them). She doesn't like the concept of having to study in front of a computer, and her mobile therefore gives her more freedom to study where she wants to. Most of her learning activities are conducted in the evening, when she does most of her studying.

She didn't think that being involved in this project had encouraged her to use her mobile for learning any more than she currently does, because she was already using it a lot.

She thinks that the University could give students more encouragement to use their mobiles, for example give interactive learning sessions on how they could use their mobiles for learning. She believes that using mobile phones can get students interested in the subject more, and they are fun and help to create enthusiasm for learning. This was her experience on the short course she attended which was mentioned earlier.

She says that many students are using their mobiles for learning. She lives in a student hostel, and has noticed that many now use their mobiles more than their laptops. There is only Internet connection on the ground floor, so you've got to physically go down there with your laptop, whereas with your mobile you can do it in your room. She commented that laptops are big and heavy, and that now a good mobile phone can cost the same as the cheapest laptop or netbook. Some students now don't actually buy a laptop because of this.

4.3 Case study 3: Heidi

Heidi is a first-year International student from Estonia, studying Public Relations. She is female, and is aged between 18 to 20. She has a Sony Ericsson G502 which she has had for over a year, and uses 'pay as you go'. Her phone can access the Internet, but she doesn't use it to access the Internet because it is too expensive. She has a PC and Internet access at home and prefers to use this.

She thinks it is important to have the ability to be able to learn at any time and in any place, as it is "more convenient". For example if you're waiting for someone you can check what you have to do for your coursework. She was undecided about being able to access learning materials on her phone, mainly because she doesn't think her phone is capable to be able to access materials, but her response would be different if she had a more sophisticated phone. She thinks it would be extremely positive for the university to contact her via her mobile for learning purposes, for example, sending text messages would be good for notifications from the university about coursework deadlines or dates for presentations.

She uses her phone for the following learning activities:

- She makes notes and takes down thoughts for coursework by saving them as text messages. She finds this a more convenient way of making notes, for example if she doesn't have a pen, or when on the tube where using her phone is easier than writing down notes in a notebook. She also uses text messages to remember things, such as room numbers for lectures and meetings and to make a note of page numbers in books that are interesting when she's reading on the tube. She often has between 40-60 saved text messages on her phone.
- She sends text messages to communicate with other students. She prefers to use this method for communication because it's more convenient and it's cheaper.
- She also makes phone calls to communicate with others. She thinks this is a more convenient method of communication because you can say what you want to say faster, and it's also more effective, because people might not see the text. If she had a mobile with a contract or cheaper calls she would make calls more often rather than sending text messages.
- Taking pictures, for example of things she needs to remember, such as an equation for her Quantitative Analysis exam. She also takes pictures to use for her coursework, such as adverts on the tube, or images she wants to keep that give her ideas.
- She often uses the calculator on her phone when she doesn't have a calculator with her (she's studying statistics as part of her course).
- At college in Estonia last year, she wrote notes in Notepad on her PC and then transferred these to her phone. She had forgotten that she used to do that and for some reason has not continued this practice.

On a daily basis she uses her phone most for texting, and then taking pictures of things. For learning, she uses her mobile most for making notes and texting other students. She uses her mobile for learning because "I know I have it on me always, and I can check it always, it's better than writing in a small calendar book for me". It makes it easier to get in touch with people, and ask for advice, and makes it easier to write essays and coursework and keep up to date with what she needs to do. However, she doesn't like to set alarms and reminders on her phone as some students do, as she doesn't like her phone "beeping" all the time.

She thinks that other students use their mobiles mainly for texting and calling. One friend has an iPhone and uses it to access University systems, such as Webmail, Evision etc. She commented that other students were "amazed" at her use of making notes as text messages (it's not a common practice). She believes that she uses her phone for learning activities about "more or less the same" as other students, probably using it every other day during the week in term time, which probably amounts to about an hour a week in total.

When asked where she tends to engage in mobile learning activities, she said "everywhere actually". For example, at university when she doesn't have a pen and needs to save some notes. She will engage in mobile learning when it is appropriate.

She felt that taking part in this research project has made her realise how much she does use her phone for studying, and found it interesting to discover the different ways she uses it. She would probably use it more in the future if she had a phone that would access the Internet cheaply. If she had cheap or free Internet and a more sophisticated phone, she could see herself using it for accessing the Internet, for email, social networking, accessing Weblearn (the university's VLE) to check announcements, and other university systems. For example she was able to check her grades on her boyfriend's iPhone last semester.

She gave one example of how the University could make it easier for her to engage in mobile learning. She liked the idea of an App that would make it easy to access University systems (WebLearn, Evision, etc), because the University is Internet-based. It would save time if you could access from a phone which you carry with you everywhere, and it would be a good opportunity for learning.

Each of the case studies illustrates a very different individual use of mobile learning. The common practices and key messages are discussed in the following section.

5. DISCUSSION AND CONCLUSIONS

The student survey has provided useful background information about the current situation of student mobile phone ownership and appropriation for learning. Whilst it focuses on students from one module, it does provide a snapshot of the reality within this group of students. The results show that all the students have a mobile phone, and that the majority possess a high-end Smart Phone (about 80%). The high percentage of Smart Phones may be because a large number of these first-year students were International students who had just arrived in the country, and will have got new phones on UK networks. 80% can access the Internet, 96% have a camera, 86% can record video and 80% can record audio, clearly illustrating that students have the capabilities in their phones to engage in a wide range of learning activities.

These students are also receptive to using their mobiles for learning. 56% of students in the survey thought it was important to have the ability to learn at any time and in any place, 29% were unsure and only 9% thought it wasn't important. Our 3 case students all thought it was important.

On being able to access learning materials on their phone, 59% thought this would be useful, 16% rated unsure, and 25% not useful. Some explanations for the more reticent opinions are provided by Heidi, who herself was unsure.

Heidi doesn't believe that her current phone is capable of accessing learning materials, but would do so if she had a more sophisticated phone and it wasn't expensive to access them. This could also be true of some of our survey students: about 20% do not have a Smart Phone and 37% are on PAYG. Conversely, Sam and Shriya thought having access to learning materials was extremely important. Shriya currently downloads learning materials to her phone from the VLE, so is clearly practicing this already.

Half of the students (50%) view the University contacting them via their mobiles for learning purposes positively, 29% were unsure and 21% viewed it negatively. Our 3 case students all had a positive view, and provide more explanation on this issue. Shriya thought that contacting students for learning via their mobiles was a faster process of communication, and was happy for this to happen, providing it was not at anti-social times (she did not think it was intrusive). Sam was happy to be contacted provided it was for learning and something useful (he wasn't happy about getting 2 emails a day about an event that was about to take place). Heidi thought that receiving texts would be good, for example to remind you about coursework deadlines or presentation dates.

Our research shows that many students are actually using whatever mobile phone they have for a wide range of learning activities. Many of the learning activities cited by students in the survey are also carried out by the 3 students who participated in the in-depth study, who also contribute more detail about what they do and why they do it. Looking at the categories of use in which students are engaging in mobile learning, the following observations can be made.

The two categories with the greatest amount of use were 'Conducting research/getting information' followed by 'Communicating'. However, it is evident that the ways in which students appropriate their mobiles in these areas, depends to a large extent on the cost of Internet access and communication services (calls, text messages etc.). 12 students in the survey and Sam and Shriya were conducting research using the Internet, but Heidi does not use her phone to access the Internet, because it is too expensive. 'Communicating' was carried out by 6 students in the survey, with 4 citing email, one using a Facebook group and one contacting group assignment members (they didn't specify how). All of our case students use their mobiles for communicating, but what is interesting is the different methods they each choose, mainly because of the cost (or lack of it). For students involved in group projects (Shriya and Heidi), keeping in contact with other students was particularly important to them. Shriya uses 'PAYG' on her Blackberry but pays £5 a month for unlimited Internet access, and communicates mainly by email, Blackberry Messenger, chat and Facebook. Using Messenger is free amongst Blackberry users, and the other methods are covered by her monthly Internet payment. Heidi on the other hand, uses mainly text messages to communicate because this is the cheapest method for her, and makes calls when that would be more effective. Sam encounters fewer barriers to cost, as he has a monthly contract which includes unlimited Internet access, and a large number of inclusive calls and texts, and tends to make calls to keep in touch with others, and also uses Blackberry Messenger with other Blackberry users. So whilst the cost of communication and accessing the Internet is an issue for students, they are able to make use of the cheapest options to meet their needs.

Uses in the other categories are more likely to be influenced by what students are able to do with their device and how they have taken the initiative to use what is available. Four students in the survey and all of our case students use their mobiles for 'Generating content/artefacts' in various ways. Taking photographs to include in coursework or a portfolio was one particular use, and used commonly by Sam and Heidi, and hinted at by Shriya (she talks about sharing pictures). Shriya also uses her mobile to write reports and coursework. Another student cited voice recording but didn't say what for. Four students mentioned that they used 'Tools/applications' on their phone for learning. 3 said they used the calculator, as does Heidi for her Statistics module. One student said they used Office, and Shriya uses Blackberry's version of this extensively, for preparing reports and presentations. Using their mobiles to help with 'Organising' their learning and their schedule was practiced by 3 students in the survey, and all of our case students to varying degrees. Sam, who admitted that his organization skills aren't very good, uses the calendar and clock to set reminders and alarms to help organize his studying and schedule. Shriya also mentioned attaching alarms to notes in Memopad, to help her remember deadlines. Heidi prefers to make reminders in the form of text messages, and doesn't like to set alarms and reminders on her phone because she doesn't want her phone "beeping" all the time. All 3 of our case students now rely on their mobile to some extent to organise their learning and maintain their learning schedule. One student mentioned using their mobile for 'notetaking' in the survey, and all of our case students gave examples of this in one form or another. Shriya uses the Memopad on her Blackberry to write quick notes. Heidi takes notes in the form of text messages, which she saves to her phone to refer to later. She also uses the camera to take visual notes of images she needs to remember (such as an equation for an exam) or that give her ideas. Sam also uses his mobile to take visual notes, of artwork in galleries to look at later or go back and capture more effectively with his camera, and to capture things he wants to remember, such as notices. 'Other' uses which don't fit into one of our categories include accessing learning materials, presentations, record presentations and transport files. Sam records lectures that he thinks will be important, and Shriya uses her phone to access University systems and download materials from WebLearn (the VLE).

Focusing on what the 3 students in the in-depth study have told us, we have an insight into why students think mobile learning is important, and where and when they engage with it. For Sam, using his phone for learning was "convenient", because it's there 24 hours a day (he sleeps with it next to him) and he has unlimited access to the Internet now. He uses his mobile for learning "when necessary", maybe once or twice a day on the days he's at University (about 3 or 4 a week). Activities tend to be located in-situ, at art galleries and exhibitions, during lectures (recording them or adding reminders) and at home for checking his schedule and what tasks he has to do. He said that any use of mobile learning was because "it would have been something that I just wanted to do, and not advised to do". Shriya uses her mobile for learning because it is easier, it is accessible (always connected to the Internet and other people), you can use it anywhere and everywhere, and prefers it because you don't have to carry a heavy laptop around with you, and you don't have to turn it on and log on to access emails. She believes that using her Blackberry "saves on time and money". She estimates using it for learning about 3-4 times a week, totaling about 20 hours. She generally carries out her mobile learning in quiet places, such as in her room, in the park around the corner, but not in the library (as they don't allow the use of mobiles). She said that she didn't like having to study in front of a computer, and that using her mobile therefore gives her more freedom to study where she chooses to. She was introduced to mobile learning on a previous course, and was made aware of the benefits, and that using mobiles had the power to "hook" you into the learning activities. Heidi uses her mobile for learning because it's more convenient and it's easier: "I know I have it on me always, and I can check it always, it's better than writing in a small calendar book for me". She says it makes it easier to get in touch with people, ask for advice, write essays and coursework and keep up to date with what she needs to do. She engages in mobile learning when it is appropriate, and says she uses it "everywhere actually". Examples she gave were at University when she doesn't have a pen and needs to write some notes, on the tube if she sees a poster to capture for her coursework or for ideas, or take notes because it's easier than finding a pen and notebook.

From comments made by these students, we can see that they are appropriating their mobiles for learning according to their individual learning needs (e.g. to facilitate group projects, generate content for coursework or for portfolios, help organize their learning, remember things, access University systems and the VLE), using the tools and services that they have available to them in their devices, and making use of what they prefer to use in their everyday practice. As Sam pointed out when asked if he was aware of how other students were making use of their phones for learning, "people are different" and individual student mobile phone use clearly reflects this, and to some extent it will also be dependent on the phone and type of contract they have. However, a wide range of mobile learning activities are being carried out, and students are resourceful in the methods that they choose to carry them out. For some students, their use of their mobile is overtaking and replacing the use of their laptop/PC.

This research helps us to better understand students' practice and attitudes towards mobile learning and therefore will help us to more effectively design mobile learning activities that build on existing student practice, and that can help to engage the students to participate in learning. It also provides an insight into the mobile phones that students have and what they can do with them, so we can design inclusive activities that a large number of students can potentially engage in.

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Raising the Bar of Challenge with Collaboration: *Social Flow* in Mobile Learning

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Abstract

Mobile learning has been built upon the premise that we can transform traditional classroom or computer-based learning activities into a more ubiquitous and connected form of learning. Tentative outcomes from this assertion have been witnessed in many collaborative learning activities, but few analytic observations on this have been made. However *Social Flow,* a concept that extends Csikszentmihalyi's flow theory, may help to explain the benefits and the triggering mechanism of collaborative mobile learning. Our empirical studies, where learners together explore a built environment as part of a simulated security guard training programme, showed that social flow in a collaborative learning space might be a key factor in providing the conditions for optimal learning experience. Further, in the experimental context, collaborative mobile learning can be seen to prompt more knowledge generation by fostering more learning motivation and ambitious behaviour (i.e., risk-taking) than other learning environments.

Keywords

Flow, Social Flow, Mobile Learning, Collaboration, Risk-taking

1. INTRODUCTION

The abundance of mobile devices is having a profound effect on the way these technologies impact on our lives. We increasingly expect to be able to work, learn and study whenever and wherever we want to, and even this current view of mobile technology is only a step on the way to ever more opportunities that will continue to unfold. The implications for informal or professional learning are also continuing to evolve, as are the notions of '*just-in-time*' learning and '*found*' learning.

The mobility and instant connectivity of current devices enable instant information access and ample interpersonal communication anywhere at any time. These benefits together lead to the assumption that learning with these devices would allow *social learning*, by which learners can work and learn together within a supportive community, and build up appropriate knowledge through active participation. By this mechanism many mobile learning researchers assert that collaborative learning would stimulate social learning and situated learning. Mandryk *et al.* (2001), for instance, showed that mobile devices could create an active participation where instant agreement (or disagreement) could take place and provide effective coordination and negotiation among learners. Further, Facer *et al.* (2004) pointed out that compared to more traditional collaborative learning activities (e.g., face-to-face in the classroom), collaborative mobile learning can create higher engagement and motivation beyond the basic learning activities, implying that people in a group might have a distinctive level of self-control over their own learning. Quite how this happens and is kept alive in mobile collaboration is still elusive, however.

As an analytic approach to address this question, the first author and his colleagues (Park *et al.*, 2010) demonstrated that Csikszentmihalyi's flow theory (1990) could account for how mobile learning can achieve these benefits, by which mobile learners (compared to game-based or other traditional pedagogies) could gain better learning outcomes. However, this study was carried out in an individual learning space, so we cannot directly apply its findings to mobile collaboration.

The primary aim of the study reported in this article was therefore to try to identify some particular outcomes from mobile collaboration, and in turn, how we might extend the analysis of flow theory to embrace the more recent concept of *social flow* (Walker, 2010), which may help us to understand the benefits and the triggering mechanism of collaborative mobile learning. It should be noted that this article does not claim that other analytic perspectives in mobile learning should be overlooked however. Instead we believe that collaboration in mobile learning may exhibit less obvious qualities in terms of these prior perspectives, and that we may see this type of learning activity from a new theoretical perspective.

Related to the viewpoint above, in this research we examine the following questions:

- *How does collaboration in mobile learning affect learning outcomes?*

Collaborative mobile learning presupposes that, as people learn or work together, the instantaneous nature of collaboration can improve learning outcomes from a social learning perspective. This, in turn, suggests that *the prompt collaboration opportunities in mobile learning would make more knowledge generation possible*. This can be seen in some ambitious projects to leverage collaborative learning by children when exploring outdoor natural or built environments (e.g., Facer et al., 2004, Spikol et al., 2008), employing the knowledge that was generated earlier by themselves or by their peers. Our study is the first to empirically demonstrate whether immediate collaboration in mobile learning, where it naturally arises from context, may present an effective knowledge elicitation and maintenance process. To our knowledge there are no prior studies in which immediate collaboration is considered as a catalyst to knowledge externalisation.

- *What would trigger collaboration in mobile learning?*

One important issue that mobile learning researchers must address is what kind of collaborative learning can we conceive of within the mobile learning space? To gain a deeper theoretical understanding of this question, three simulated learning systems for security guard training were considered (*mobile learning with no collaboration*, *mobile learning with collaboration*, and *face-to-face collaboration*; Refer to Section 3 for more details.) Of course, in this experimental setting, it would not be easy to observe any significant benefits from collaboration over the very short term. Hence we discuss if these distinct forms of learning activities could resort to Csikszentmihalyi's flow concept to conceive a formative stance for collaborative mobile learning.

A note regarding our research methodology is needed here. We did not frame bold hypotheses in advance or plan to test by empirical study. Rather, we had observed what happened when people had opportunities to learn together and begun to question how collaboration in mobile learning affects learning outcomes. From this, an inductive logic came into play to see if the concept of social flow could be applied to the question of what factors might trigger collaboration in mobile learning.

2. WHAT TRIGGERS COLLABORATION

Learning has been characterised in a number of ways. For example, *traditional constructivism* emphasises that learning is intrinsically internal and personal, involving the generation of new understanding and knowledge and active changes in conceptual understanding. Next to this solitary learning space, *socio-cognitive perspectives* on learning theory now place emphasis on learning as an active and social participation process, in which possibly collaborative interactions are viewed as a key construct of the content of learning activities (Lave and Wenger, 1991). That being said, many mobile learning projects owe much to outdoor learning activities (e.g., Rogers et al., 2002), where the context can intrinsically trigger the collaborative nature of learning.

To draw upon this collaborative nature of learning, many have tried to present some conceptual theories, such as *Learning Spaces Design Framework* (Ryu and Parsons, 2008), *Activity Theory* (Engeström, 2009) or *Flow Theory* (Csikszentmihalyi, 1990). The *Learning Spaces Design Framework* sets out three learning spaces: individual, collaborative, and situated. Within these different learning spaces, the framework outlines the essential factors for effective mobile learning experience design that should be addressed by different features or functions of the relevant learning spaces. In particular, it argues that collaborative learning could be even more effective when learners can converse with each other, by interrogating and sharing their descriptions of the learning content. Here, the capabilities of mobile devices uniquely contribute to foster collaborative learning activities, and in turn, this learning is no longer static subject matter but the process of participating itself. In effect, collaboration is triggered by the technical capability of the devices rather than the intrinsic nature of learning activities. However this techno-centric perspective seems to be unlikely to capture the critical qualities of collaboration, so a more inclusive framework becomes necessary.

Engeström (2009) partially answered this issue; collaborative learning could be triggered by tightening the social bonds that make communities knowable and liveable, emphasising the role of mobile communication. By this he means that individuals or groups in a coherent social community could create and maintain their own collaborative learning practices, by developing collective concepts with the active help of all the participating learners. In a similar vein, Spikol *et al.* (2008) have seen peer-to-peer collaboration as this 'friendship' process, by which learners become collaborative meaning-makers among a group defined by common practices, language, use of tools, values, beliefs and so on. Both frameworks can reason about what makes the collaborative learning process explicit, but quite how the social bonds trigger collaboration is still open to question.

In approaching this question, we may assume that sustaining high personal involvement to reach agreement, or resolving conflicts (i.e., disagreement) between peers, might be compelling areas to examine. Neither the learning spaces design framework nor the frameworks grounded on activity theory can explain what would trigger highly interdependent collaboration, or what motivates peers to collaborate with each other. To this end, the concept of flow in a social context can be viewed as a new analytical lens.

2.1 Flow Experience

Prensky (2000) surmised that the best learning moments usually occur when a learner is stretched to the limit in a voluntary effort to accomplish something challenging and worthwhile, consistently generating *flow* experience (Csikszentmihalyi, 1990) that sustains the learner's efforts to achieve something. He saw that game-based learning would be of great value from this perspective, and indeed it is clear that game-based learning activities can be more joyful and fun, at the very least, and are thus able to keep alive motivation to learn. As such, Csikszentmihalyi's Flow Theory (*ibid.*) has, to a larger extent, provided an analytic foundation to decipher users' positive or negative experiences in many Human-Computer Interaction (HCI) research arenas.

Though there are many different definitions of flow, it is generally said that flow is a holistically controlled feeling where one acts with total involvement or engagement with a particular activity, with a narrowing of focus of attention (Csikszentmihalyi, 1990). From a mobile learning perspective, it implies that, in order for learners to experience flow whilst engaged in a mobile learning activity, they must perceive a balance between their skills and the challenges of the activity, which should present them with playful interaction, exploratory behaviour and positive subjective experience. For instance, both the Savannah project (Facer et al., 2004) and the Ambient Wood project (Rogers et al., 2002) allowed a high level of self-control over the learning content to construct a more pleasing learning experience. Given that self-control is intrinsic to mobile learning, the relative levels of challenge and skill may either facilitate or block the motivation to learn. This learning manipulation through the levels of challenge has been found to contribute to the development of knowledge structure and acquisition (Kozlowski et al., 2001). That is, at a given moment, individuals are aware of a certain number of opportunities challenging them, while they assess how capable they are of coping with these challenges. If the challenges of an activity are beyond the individual's skill level, demanding more than the individual can handle, they may disengage from further learning. On the other hand, if the challenges are lower than the individual's skill level, boredom may be the result, also leading to disengagement. This has been observed in many of the mobile learning projects mentioned above. In effect, the core part of the optimal flow experience can be briefly characterised in four dimensions. These four dimensions of flow incorporate the extent to which (a) the learner perceives a *sense of control* over the learning activity, (b) the learner perceives that his or her *attention is focused* on the learning activity, (c) the *learner's curiosity is kept aroused* during the learning activity, and (d) the learner finds the learning activity *intrinsically interesting* (Csikszentmihalyi, 1990; Park *et al.*, 2010).

To briefly explore these four dimensions further, we begin with *control*; flow theory can be used to examine the process of achieving learning outcomes through control over one's learning activities. For a learning activity to encourage playful, exploratory behaviours, learners should experience a feeling of control over the whole learning activity, so they will be motivated to work on longer learning tasks in the face of tempting distractions. Secondly, as a consequence of the feeling of control over the learning activity when in the optimal flow state, the learner's *focus of attention* is narrowed to a limited stimulus field (or content, in our case), filtering out irrelevant thoughts and perceptions. The person in the optimal flow experience becomes absorbed in the learning activity, and is more intensively aware of his or her own mental processes, thereby enhancing relevant mental activities such as remembering, thinking, feeling and making decisions. It is widely thought that attention is a sufficient tool for the task of improving the quality of learning experiences (Webster and Martocchio, 1992). However, learners are more motivated when the learning design generates *curiosity* and *interest* about the content and learning context. The Ambient Wood project and many game-based learning systems are examples that maximise these factors in instructional design.

Prior research suggests that optimal flow experience in learning activities may lead to higher quality individual learning outcomes, encouraging each learner to be more adaptable to changing environments or new learning content, and constructing creative solutions to problems with no known solutions. Previous work has used flow theory in explaining higher motivation (i.e., situational goal generation) in solitary mobile learning, and demonstrated that flow experience would be a springboard to extend individual learning experience (Park *et al*., 2010). However, this did not further articulate flow theory to encompass collaborative learning experience, which is central to this study.

2.2 Raising Challenge Levels: Social Flow

It is becoming popular to talk about how we play computer games *socially*. Games such as Rock Band™ and Little Big Planet™ are designed for groups of friends to play or work on together. And even casual online games like Farmville™ are using the desire to play with friends to increase their user base. These are touted as successful social gaming environments, and also enable players to participate in embedded learning tasks, such as developing skills in music rhythm and pitch awareness. The reason why we play or work on together seems quite intuitive – '*if you are playing (or learning) with other people, at least you might be contributing to someone else's happiness*,' which many social scientists and philosophers (e.g., Benthamites) have also concluded. Csikszentmihalyi (chapter 8, 1990) further maintained that the flow experience in either 'being alone' or 'being with others' might differ. With this in mind, learning designers often try to implement 'sociability by design', in other words, to structure learning activities so that learners will have numerous opportunities to simply 'hang out' with each other and thus form interesting relationships to work together.

We may establish a rather different view of this empirical approach to learning. Many game researchers have already judged the social game on its merits from the fact that people would join with others to tackle more challenging tasks. That being said, the relative levels of challenge and skill that the group will face together might be key to see the distinctive nature of *Social Flow* experience. Of course, we might be able to apply an individual's solitary flow to social flow experience as a whole, using a kind of simple arithmetic to add up pleasures and subtract unhappiness from them. However, people do not necessarily associate their own interests with the group's interest, and it would be wrong to say the total solitary flow experience of all individuals is equal to the social flow experience among all individuals in it. Therefore, the kind of social behaviour required for this collective flow experience has to be considered, particularly for learning activities.

This implies that one of the most important elements of these social experiences might be shared social interaction where people can go above and beyond their normal range of ability. Recent biological evidence supports this contention, suggesting that team-play allows individuals to take on more risks and challenges (i.e., higher risk-taking social attitudes) than when working alone (Cohen et al., 2009). The benefits of mobile learning can be seen from this collaborative learning perspective. People in collaboration would have more opportunities to learn something in this social flow from the challenges taken by their peers. Hence, at a given moment, they can assess how they are capable of coping with these challenges together, lifting the overall levels of challenge. Quite possibly, learning alone would have minimised the taking of further challenges, but when people work together, they are readily able to raise the levels of challenge to do further learning activities. Interestingly, this runs counter to Csikszentmihalyi's (1990) claim that the 'natural' or 'unlearned' pursuit of self-interest contributes to the greatest happiness.

As to the concept of *social flow*, it is important to discuss Walker's work (2010), which addresses what happens when a group of people are absorbed together in a challenging physical task. In his first study, the participants thought more collaborative physical activities (e.g., playing football or walking in groups) were associated with more joy than solitary activities. The following two experimental studies further articulated the concept of social flow, revealing that the collaborative physical activity was rated as being more enjoyable and provoked more emotions usually associated with flow experience, including feeling alive, focused and cheerful. Also, the participants with a 'high interdependent' relation to each other were rated as more joyful than the participants in the low interdependence condition. Crucially, the highly interdependent participants were still rated as more joyful even when the analysis was restricted to just those participants from each condition who had found their respective tasks equally challenging and requiring of skill. In other words, with flow experience kept as constant as possible across the two conditions, the more interdependent version of the physical activity still appeared to provoke more enjoyment. Thus it can be seen that people working together actually raise the levels of the challenge of a task. This triggering mechanism would explain why collaboration would increase their motivation, and as a result, the concept of social flow could be central to mobile learning research. This possibility has not been discussed in the literature, and the research objective of this article is to see if this kind of social flow can be observed in a collaborative learning activity, and in turn, if mobile learning can extend this new form of flow experience.

3. EXPERIMENTAL STUDY

The main purpose of this experiment was to explore whether collaboration via mobile devices could be associated with a rather different learning experience. If this is the case, then we seek to answer the different learning outcomes from social flow. To empirically examine this, it was necessary to examine a collaborative learning activity in a natural learning setting. This would allow one to identify how mobile technology achieves a critical collective learning objective, and eventually how the benefits of mobile learning may be naturally perceived by the contributing learning partners.

A simulated but realistically situated learning programme was thus developed to train security guards. The programme was set up to allow the participants to separately patrol several physical locations in pairs, to find as many security issues as they could, and collaboratively learn from each other. Three types of learning system – 'solitary' mobile, 'collaborative' mobile, and 'face-to-face' collaborative learning – were developed to assess the differences in both learning outcomes and flow experiences rated by the participants. All the systems allowed the trainee guards to participate in a security patrol mission by using a mobile device, encouraging them to act both on their own and collaboratively, and construct their own knowledge of the patrol mission, as well as sharing knowledge with other trainee guards, if necessary. Six patrol locations were arranged at Massey University, and each patrol location had instructions for the trainees to learn (Figure 1).

Figure 1. The system guided trainees to locations where they were given instructions.

The same six locations were used throughout the experiment, and each subject in the collaborative conditions (i.e., mobile collaboration and face-to-face collaboration) only visited three areas personally, to deliberately simulate a collaborative learning context. This experimental setting would jointly allow every pair to learn the six places together. The participants in the 'solitary' learning condition were asked to complete the six patrol tasks alone, as a control condition.

3.1 Participants

Forty-five trainee guards volunteered, none of whom had physically explored the premises before. They had a similar educational background, aged 20–28. Only five were for the solitary learning system control condition. The rest of the subjects were assigned at random to one of the two collaborative settings (ten pairs to mobile collaboration, and the other ten for face-to-face).

3.2 Experimental Design

The experiment was a between-subjects design. The three types of learning systems given were the between-subjects independent variable, while the dependent variables were the ratings on statements regarding the flow experience (see below); learning performance of how well each participant had learnt the patrol instructions from both their visit and their partner's visit (i.e., un-visited); types of knowledge generated (problem, theory, agreement-disagreement or suggestion) and the level of knowledge described in their self-report.

3.3 Apparatus

Each participant was equipped with a mobile device (Nokia E71™ or E66™ with 3G network connections) installed with the "Online Patrol Training System" as depicted in Figures 1, 2 and 3. The difference between the two collaborative systems is that the mobile collaboration supports instant exchange of text and photo messages between the trainees (Figure 2).

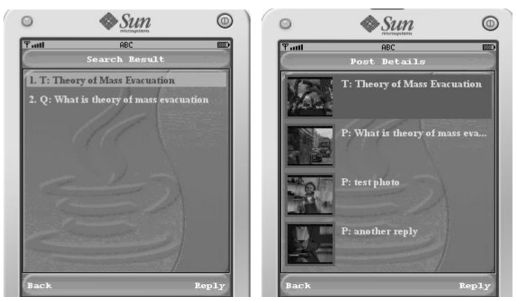
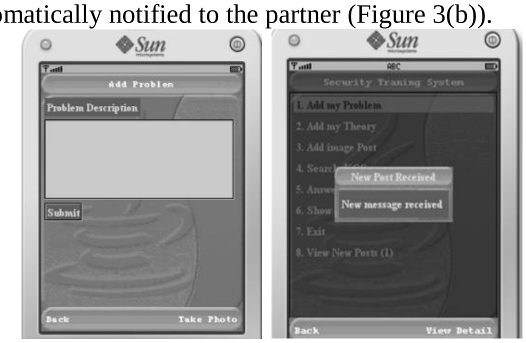


Figure 2. Text/Picture based collaborative communication.

On the other hand, the face-to-face collaboration only allows photos and uploads them to a server for their face-to-face collaboration just after their patrol. That is, the mobile collaborative system allows our participants to instantly communicate with each other (see Figure 3(a)), i.e., as soon as new texts or photos are added, they are automatically notified to the partner (Figure 3(b)).



(a) (b)

Figure 3. Working together each other. (a) Adding up new information; (b) As soon as new information is added, the partner is automatically sent the notification.

In contrast, the face-to-face collaboration does not allow this instant communication. As a counterbalance to this, trainees can take photos, upload them to a server, and later on view them together in a wrap-up session in order to give them the opportunity to externalise or build up the knowledge they want to share with their partner. We believe this time-delayed collaboration can present what is lacking in the collaborative learning experience, in terms of social flow and learning outcomes related to mobile learning.

To examine if the trainees had retained certain learning outcomes, a retention test was administered the next day, with six multiple-choice questions related to the six patrol locations. An important note is needed here. Each participant had physically visited only half of the six locations, so they had to answer questions about the un-visited places based only on their collaboration during the patrol (mobile collaboration) or the wrap-up session (face-to-face collaboration). Thanks to this manipulation, the retention test (i.e., if they could answer the half of the questions from their own learning, and the other from someone else) is expected to show the effects of mobile collaboration, if any.

The seven statements relating to flow experience were then rated on a five-point Likert scale. These were developed from the first author's previous work (2010), which suggested the benefits of mobile learning can be seen by the optimal flow experience aroused by '*cognitive curiosity*' and '*intrinsic interest*'. The last statement was inserted to see if working in a group would prompt them to tackle more challenging tasks, as a result of being further motivated. If this was the case, we would be able to see collaboration as a key benefit and thereby influence a trajectory of mobile learning curriculum development.

- *Q1 (Cognitive Curiosity): Working together with my partner excited my curiosity;*
- *Q2 (Cognitive Curiosity): Interacting with my partner made me curious;*
- *Q3 (Cognitive Curiosity): Working together with my partner aroused my imagination;*
- *Q4 (Intrinsic Interest): Working together with my partner bored me;*
- *Q5 (Intrinsic Interest): Working together with my partner was intrinsically interesting;*
- *Q6 (Intrinsic Interest): The whole learning session working with my partner was fun;*
- *Q7 (Risk-taking): Working with my partner allowed me to look into other issues rather than the patrol instructions given.*

3.4 Procedure

Figure 4 shows the procedures for each experimental condition. All the participants attended a tutorial session that gave them the necessary information to carry out the experimental task, including the six locations to be patrolled and how to use the "Online Patrol Training System" (see Figures 1-3). In the main experimental session, they were told to visit the locations, find some security issues related to their visits, and, if required, to take photos of the site and describe the issues when submitting them to the database.

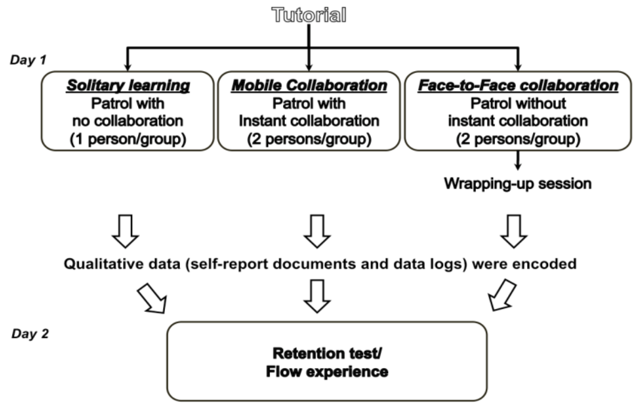


Figure 4. Experimental procedures. Note that face-to-face collaboration has a wrap-up session.

To ensure the quality of the descriptions of the issues (i.e., *knowledge*), they were encouraged to think creatively and act collaboratively during the patrol, externalising their knowledge by proposing their problems and/or theories. For instance, when a participant describes an issue such as *'the traffic barrier at Gate 3 is visually too weak'*, then he or she takes photos of the barrier and submits the knowledge together with the photos to the database. However, this free style description would make eliciting knowledge quite onerous. Hence, they were asked to use some '*scaffolding*' words, as used in the "Online Patrol Training System." Table 1 exemplifies two subjects contributing their opinions by using the scaffolding words.

Table 1. Scaffolding words used in the experiment

[**Problem**] *Person A*	There are not enough security cameras at student car park A.
[**Theory**] *Person B*	Car park A is frequently patrolled, so it is relatively safe.
[**Disagreement**] *Person A*	I disagree. As the car park is completely open, it is hard to secure the entire area.
[**Agreement**] *Person B*	I agree with Person A.
[**Suggestion**] *Person B*	The student car park needs more security cameras to cover the entire area.

In contrast, for face-to-face collaboration, subjects were only allowed to take photos, and no immediate collaboration was available during the patrol. Hence, each participant only learnt about half of the six locations during their own patrol, and received no information relating to the other locations. As a compromise, as soon as they finished their patrol they attended a wrap-up session with their partner. In this meeting they were asked to externalise their knowledge or learn from each other, and a desktop computer with a 24" monitor was used to facilitate this collaboration process showing all the photos they had taken. The subjects were then told to use the same scaffolding words (i.e., problem, theory, agreement-disagreement, suggestion) to compile their knowledge and generate a document. All the experimental sessions were conducted pair by pair, and each pair completed the whole experiment in about one hour.

4. RESULTS

As depicted in Table 2, our participants in the face-to-face collaboration seemed to perform the experimental task poorly, when compared with the other two experimental systems. This might indicate limitations to this type of instructional design in training programmes, where physical visits or instant collaboration is essential. Note that the face-to-face collaboration did not allow the participants to physically visit all of the six places, nor have instant communication. Importantly, this seems to indicate that instant collaboration through mobile devices has a certain effect against the face-to-face collaboration, regarding learning about the un-visited places. Note that both systems asked the participants to visit the half of the six places, which positioned collaboration (either instant or delayed face-to-face collaboration) at the centre of the learning affordances of the two systems, against the solitary learning where there was no collaboration.

Table 2. Learning performance (Mean/S.D, max: 100).

System	N	Visited	Un-visited
MS learning[*]	5	91.90 (16.44)	-[**]
MC learning[*]	10[***]	89.85 (19.27)	84.70 (17.35)
FtFC learning[*]	10[***]	81.40 (23.11)	71.25 (22.554)
sig.		n.s	p≤.05

[*]MS – Mobile Solitary; MC – Mobile Collaborative; FtFC – Face-to-Face Collaborative; [**]Mobile (Solitary) learning asked the participants to visit all the six locations, as a control group; [***]10 pairs=20 subjects.

A T-test was conducted on the learning performance of the un-visited places, revealing that there was a significant effect of the given system (t_{38}= 2.12, $p \leq .05$). This can be interpreted that the participants working together with mobile learning effectively learnt by collaboration, with the support of the knowledge generated by others. However, the participants in the face-to-face collaboration had to wait till the wrap-up meeting, and then learned from each other, which could be less motivating than it is in the mobile collaboration. The data can be taken to suggest that, at the very least, the benefit of instant collaboration is evident, a factor not present in the face-to-face collaborative learning.

As another learning outcome, for mobile collaboration, participants' communication logs were recorded. For the face-to-face collaboration, the subjects met face-to-face after they had completed their patrols, and their conversations in the wrap-up meeting were also documented and encoded. To explicitly see how the participants generated their knowledge, the researchers analysed the encoded data by using the verbal protocol analysis method. After encoding the raw transcripts into segmented sentences, they were further matched into the five pre-defined coding categories, with the scaffolding words, i.e., problem, theory, agreement (disagreement), and suggestion.

Table 3 summarises the data collected, together with the mean communication events for the two collaborative systems. Note that the solitary learning system had no collaboration, so it was not analysed here. Overall, the two collaborative systems did not exhibit much difference, except for agreement (disagreement) being significantly higher for the face-to-face group. A T-test confirmed this (t_{38}= -3.97, p≤.01). A possible explanation may be that the participants in mobile collaboration could check and interrogate their knowledge on the spot; on the other hand, the participants in face-to-face collaboration needed a heavy negotiation processes to build up a consensus in the wrap-up session.

Table 3. Mean frequency of each coding category

	Problem	Theory	Agreement (Disagree)	Suggestion
MC	4.20 (1.94)	5.65 (2.28)	1.13 (1.02)	3.30 (1.59)
FtFC	3.95 (2.30)	5.05 (2.21)	2.50 (1.49)	4.20 (1.64)
sig.	n.s	n.s	p≤.01	n.s

This interpretation was partially supported by inspecting the type of the knowledge generated, as shown in Table 4. We analysed this, separating out '*knowledge by collaboration*' and '*knowledge without collaboration*'. The former refers to the information in the generated transcripts, which was created from the pair's collaborative effort, and the latter for being generated individually, without conversing or consulting with the other peer. Since the participants used the scaffolding words to build up the transcripts, any context-related information in the 'Q&A' structure has been counted as '*knowledge by collaboration*.' Looking at Table 4, it appears that the mobile collaborative learning system generated more knowledge from their collaboration, and this was assessed by a Chi-square test (χ^2= 14.18, p≤.01).

Table 4. Mean frequency of each coding category

System	Knowledge by collaboration	Knowledge without collaboration
MC	122	145
FtFC	72	172

Contrary to the three learning outcomes above, the ratings of flow experience revealed a striking difference, which might suggest the distinctive nature of mobile learning experience, and possibly the implications of social flow. '*Cognitive curiosity*' and the desire to attain competence with the learning application may motivate learners to develop more skills or further examine the learning space, so higher ratings on these statements imply willingness to exploit the learning system further. '*Intrinsic interests*' can be termed as subjective experiences during interactions that are characterised by perceptions of pleasure and involvement. Higher ratings on these questions mean the learners are so intensively involved in the learning activity that paying additional time and efforts in the learning activity does not seem matter. Finally, 'risk-taking' behaviour is associated with these two contributors, in that it can generate a further motivation to learn. This is more likely to lead the group to find new sources of knowledge through collaboration, outweighing the possible negative effects of collaboration such as the additional time and effort required. Hence, it can be seen that higher risk-taking behaviour by individuals may have benefited the group as a whole, because the group would reap the rewards of the higher risk taker's discoveries.

Table 5. Mean ratings of the flow experience

System	Cognitive curiosity	Intrinsic interest	Risk-taking
MS	2.52 (0.83)	2.71 (0.92)	1.35 (0.77)
MC	3.80 (0.77)*	3.88 (0.75)*	3.95 (0.89)*
FtFC	3.20 (0.95)	3.00 (1.08)	3.25 (0.79)
sig.	p≤.05	p≤.05	p≤.01

*For each contributor were averaged out to give one face value in each column; *Significantly different from the others by a Tukey test* at p≤.05

Table 5 gives the mean ratings for the three experimental settings across the two contributors to the flow experience. Arguably, the last item is considered as a mediator to bridge them for collaborative benefits. In all cases, collaborative mobile learning gives the higher ratings, which indicate our participants had somewhat different flow experiences in mobile collaboration. A one-way between-subjects analysis of variance was applied, followed by a Tukey test (at p ≤.05).

5. CONCLUSIONS AND DISCUSSION

When considering the impact collaboration has on a learning activity, our empirical data showed that when potential learners had manageable challenges, and they saw them as positive self-improvement opportunities, then an intention to collaborate was triggered. This was not the case in a solitary learning environment or time-delayed collaboration, where the participants can simply choose to "not learn" and maintain the status quo at no cost. This study also suggested the social flow experience effect as one potential analytic viewpoint from which to see the benefits of collaboration in mobile learning. Indeed, we posited that social flow might account for collaborative learning outcomes, but we did not actually form this hypothesis for the subsequent empirical study. Instead, we simply hoped to observe that potential collaborators are more likely to be motivated to learn together based on their shared situational goal orientation. Comparison of the three experimental configurations allowed us to pinpoint the potential value of the collaborative mobile learning experiences available in this context. The evaluation of social flow experience and risk-taking behaviour explicitly confirmed the significant advantages of collaborative mobile learning over the other formats.

Many educational practitioners have long believed that collaborative learning activities enable exchanges of thoughts, emotions, and ideas among learners (Childress and Braswell, 2006). In turn, this bonds them with others participating in the same learning activity (i.e., forms a learning community), which is likely to improve their achievement. The main contributions of this article are to empirically demonstrate that this social flow experience can be maintained in collaborative mobile learning, and further that each individual's solitary flow experience cannot displace the group's collective flow experience.

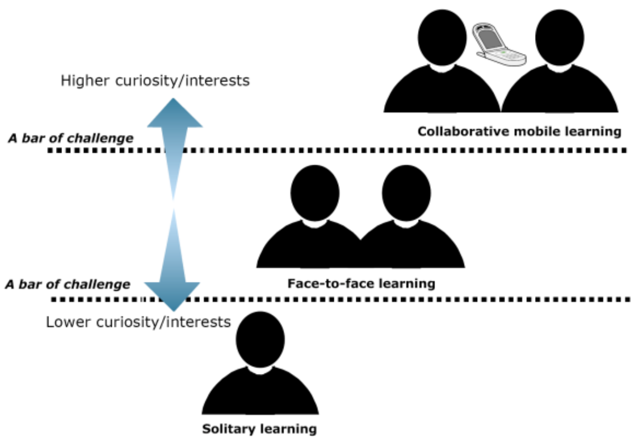


Figure 5. Social flow to raise the bar of challenge

Based on the findings discussed above, Figure 5 sketches out the concept of social flow, whereby groups can raise the level of challenge in performing a learning activity together. In such cases, learners are more motivated when the learning design generates higher curiosity and interest about the content and learning context. In that context, mobile learning would have the effect of uniting them together, in order to gain the collective flow experience by tightening social bonds. That is, collaborative partners with the same learning goal orientation can have adaptive responses to new and/or challenging situations. In particular, individuals displaying this orientation would treat new and/or challenging situations as opportunities for self-improvement through collaboration given by the mobile learning activity.

The results of this study also raise several questions that could be pursued, and the limitations of this study need to be fully addressed in future work. For instance, the communication in this study was based only on text and photographic images, and it is possible that richer types of communication such as video streaming might lead to rather different learning outcomes. Studying how peers might co-develop a challenging task for their learning activity, and how they would work adaptively together on that task, would be another way forward for validating social flow experience effect in collaboration. Social flow is a concept that has only recently come to the attention of learning researchers, but there is much potential in further exploration of its implications for collaborative mobile learning.

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Integrating Mobile Learning into the Tertiary Environment: The Educators' Perspective

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Abstract

Mobile technology has become to be seen, in some academic circles, as a way to enable learning - learning that is not confined by time and place. Mobile technology is still in the early stages of its adoption, and its true value and impact on education is still to be clarified. The future adoption of mobile technology will largely depend on the perception of students' and educators' on whether mobile technology fits within their particular context and needs. The decision of both students and educators to adopt mobile learning is a complex process with a wide number of influencing factors. This study aims to highlight the factors that will impact on the future adoption, or possible resistance, to the introduction of mobile technology, within the tertiary environment as perceived by four tertiary educators who have recently adopted some form of mobile technology to support their teaching.

Keywords

Mobile learning, educators, barriers, enablers, teaching, education.

1 INTRODUCTION

The term mobile learning (m-learning) refers to the use of mobile and handheld devices, such as Personal Digital Assistants (PDAs), mobile telephones and MP3 players, in supporting teaching and enabling learning. As computers and the Internet become essential educational tools, and the technology becomes more portable, affordable, effective, and easy to use, so too have they become the focus on how they can be incorporated to support learning. These technologies provide many opportunities for widening participation and enable easier access to learning. Mobile devices such as phones and PDAs are more reasonably priced than desktop computers, and therefore, present a less expensive method of accessing a myriad of tools all in one small device. Feature such as the facility to make phone calls, take pictures, record audio and video, store data, music, and movies, and interact with the Internet all provide opportunities that could be harnessed in the educational context. As new devices continue to enter the market, new features and capabilities are appearing at an accelerated pace. Mobile learning offers a fundamental change in the way learning can be regarded and opens the door to countless uses for educational purposes.

The decision of educators to integrate mobile learning into their teaching is a complex process with a wide number of influencing factors. A key question in trying to determine future adoption with the technology environment is determining why an individual would adopt one technology while resisting another. According to Straub (2009, p. 626) "technology adoption is (a) a complex, inherently social, developmental process; (b) individuals construct unique (but malleable) perceptions of technology that influence the adoption process; and (c) successfully facilitating a technology adoption needs to address cognitive, emotional, and contextual concerns". The aim of this paper is to provide an initial insight into some of these factors that may affect the adoption of mobile technology into education. In addition assess the initial attitudes these educators have concerning this introduction. Examples of current teacher use of mobile technologies in their teaching are discussed, as well as what issues are currently hindering the adoption of mobile technology in the tertiary environment.

2 THEORETICAL FRAMEWORK

When incorporating Information and Communication Technology (ICT), particularly mobile technology into a learning environment it is important to consider the impact that teachers have on the process by either supporting or inhibiting it. While educators may be familiar with mobile technology in general, they may not be prepared or able to integrate mobile technology into their teaching. According to Abrami (2001) the reasons for not incorporating ICT into teaching can be varied. The aspects that relate to mobile technology incorporation include:

- Educators feel ill at ease when using technology in the classroom and would be less likely to adopt a new form of technology such as mobile technology.
- Educators may not feel enthusiastic about technology in general and therefore less likely to adopt mobile technology.
- Educators may not be using mobile technology to its potential as a cognitive tool due to teachers' lack of skill in using this technology or lack of awareness regarding its potential.

Individual beliefs play a significant role in their adoption of new technology (Dexter, Anderson, & Becker, 1999; McVee, Bailey, & Shanahan, 2008; Mercer & Fisher, 1992; Punya & Matthew, 2006). Educators are the focus of interest, of this study, as they have the primary contact with students, have to overcome the barriers, which mobile technology may through up, and provide the support to integrate instructional technology (Mueller, Wood, Willoughby, Ross, & Specht, 2008).

Research has shown that an educator who feels ill at ease with using technology has probably had negative experiences of tying to use ICT in their classrooms. On the other hand, an educator who has had positive experiences with ICT tools will be more willing to experiment and introduce other type of instructional technology into their teaching. One key aspect which determines introduction of any technology is whether users perceive that there is a need for the new technology (Keefe, 2003). Mobile learning, in particular, is considered by some as unsuitable for the learning environment. Educators need to be convinced that there is a real benefit from using this tool and need to be guidance its integration into the learning context. Caspi and Gorsky (2005) demonstrated that if a person is more skilled in one form of instructional technology, such as computers they are more likely adopt and use new forms. The more a person uses technology (such as elearning) the more likely they are to adopt new ways of using the technology and also include a wider range of technologies in their teaching.

Overall, how educators perceive instructional technology and its integration in their teaching, impacts on the level of usage in the classroom and the inclination of educators to introduce new technologies. However, attitude to technology in general does not, by itself account for the failure of educators to adopt mobile learning. Information specific to their attitudes to mobile learning is needed to more fully understand their response to this new technology.

A number of studies have looked at the key benefits that mobile technology offers educators. In Kim, Mims, and Holmes (Kim, Mims, & Holmes, 2006) these have been summarised into four main groups:

- providing students (and educators) with freedom of location and time;
- increasing speed in teaching and learning;
- enabling one-to-one learning based on individual educational histories or test results; and
- allowing teachers to keep up the new educational subjects for future education.

Overall, mobile learning is a relatively new technology and how it will impact the teaching environment will be determined to a large extent by educator's perception of its value. The educators' attitude and previous experience will possibly have a key role in whether or not they will adopt mobile technology.

This paper reports the results of a series of interviews with four tertiary educators, who have been involved in utilising mobile technology to facilitate their teaching. The interviews focused on collecting the educators' attitudes and opinions on the inclusion of mobile technology in the tertiary environment. The study focused on determining the key themes which will affect the adoption of mobile learning in tertiary setting.

3 METHODOLOGY

3.1 Participants

The authors interviewed four educators, comprising of three tertiary lecturers and one e-learning advisor at one of the tertiary institutes in New Zealand. The four research participants were selected because they we recently involved in a recent study were educators were given access to a mobile device which they could use to support their teaching. The participants were not given any direction on how they should use the technology, but rather they were encouraged to explore how mobile technology could be used to suit their particular teaching environment. Short descriptions of each participant are provided here to give an insight to the context of the study:

- Educator A, is an e-learning advisor, her job is to provide support and training for educators. Her role includes carrying out workshops and one-on-one training on the use of technology in teaching. As part her role as advisor, she is continuously looking at how technology can be used to support educators and students alike – she has therefore been provided an iPhone to investigate its use in educations as well as support her own teaching.
- Educator B, is a secondary education lecturer. His responsibilities include introducing his trainee teachers to the use of technology into the classroom. He has recently been looking at how his students can use technology – in particular mobile technology in their own teaching.
- Educator C, is an Information Technology lecturer his passion involves using constructive technology to support his teaching. As part of this study he was given a number of different mobile devices (ranging from a fairly standard E51 Nokia to an iPhone) and was asked to determine how it could be used to support his teaching.
- Educator D, is also a Information Technology lecturer. She has recently been away on maternity leave and has only returned to her role earlier this year – however only part time. Since she is working part time and juggling a small child, her time is limited she has therefore adopted mobile technology to help coordinate and support her teaching. She is currently using an iPaq HP hw6915 Smartphone.

The educators in this study are all self confessed technology enthusiasts and early adopters of technology. Their views are not intended to give the full spectrum of possible perspectives towards mobile inclusion; however, they do provide an initial perspective into mobile technology introduction into the tertiary environment.

3.2 Data collection

Semi-structured interviews were conducted with the participants of this study, which focused on collecting their views of, and experiences with, mobile technology in their teaching. The study focused on how they used the mobile technology in their teaching, the future of mobile learning and the issues that will influence the adoption of mobile technology in the future. These key questions, acted as a guide for the structure of the interview, however as the interview progressed the interview was open for any other related avenues. The interviews ranged in length from 40–90 minutes.

3.3 Data Analysis

This study focused on collecting the actual and potential use of mobile technology in education, from an educator perspective. The study sought to draw out the key elements and themes that would influence mobile technology adoption. This study utilises the constant comparative method (CCM) to analyse the qualitative data collected from the interviews. CCM involves categorising the data from the interviews, and then continually examining it for examples of similar themes. The themes that emerge from this evaluation were used to capture or summarise the data collected from these interviews (Thomas, 2009). The selection of this method, to analyse the results of these interviews, was particularly appropriate as the results of this study was used to form the early explorations of emerging practices in the use of mobile technology in the tertiary environment (Aubusson, Schuck, & Burden, 2009).

The major findings identified in this study related to the versatility of mobile technology use in the teaching and learning, device ownership, technology, institute support and policy, and ethical issues.

4 RESULTS

There are many factors that may impact the uptake of mobile technology to support learning and teaching. The results gathered from the interviews with the participants were broad ranging and diverse, however they all can be categorised into four broad categories; sociocultural, organisational, pedagogic and technological. These categories were drawn from work by Collis (1995) and Trinder et al (2008). Each factors can interrelate with the other, for example pedagogical issues have associated technological and sociocultural dimensions. These factors have been used to group the key findings, identified in this study.

4.1 Sociocultural issues

In Schuck and Kearney (2008), they describe sociocultural issues as those being related to historic, cultural and societal contexts of the learning environment. There is an emphasis on the use and availability of educational tools, and their impact on the environment. There are a wide range of influences on the adoption of mobile learning, issues such as attitudes, abilities and perceptions of those around will all impact on the use and the residual benefits of mobile technology.

The availability of mobile technology will have a huge impact on the use and adoption of mobile learning. One of the biggest themes, highlighted in this study, was the issue of ownership. In New Zealand, most people own a mobile phone and some students, in particular, have two mobile phones (Cameron, 2006). However, the types of mobile devices which are owned by students and educators are not necessarily suited to mobile learning. More sophisticated devices, such as iPhones, are costly and therefore, not many students have these sorts of devices. Lower end devices can be utilised for mobile learning, however, the range of possibilities are limited. In this study, the mobile devices, used by the educators, were either lent to them by the researcher or supplied to them by their departments. In Olney and Lefoe (2008), they highlight the need of ownership, when the educator owns the device, or acts if they own the device, they are more inclined to explore the affordances of these devices.

Overall, for educators to explore and develop their use of mobile technology, it is important to recognize that mobile devices are a personal device and that ownership is needed to encourage educators to commit and adopt it into their everyday lives, and therefore develop familiarity, expertise and confidence (G. Lefoe & Olney, 2007). This concept was elaborated in Lefoe et al. (G. Lefoe, Olney, Wright, & Herrington, 2009, p. 25) where they state that the ‘significance [of mobile technology] was the ability for faculty to be able to use the devices in their everyday work and to become familiar with them to such an extent that they were then able to incorporate their use in the curriculum’.

The introduction of new tools and technology needs to be considered, in particular, in terms of the diversity of the learners and educators. As described in Prensky (2001), mobile learning may seem natural to digital natives (e.g., incoming students) but foreign to digital immigrants (e.g., the vast majority of instructors). It is important to consider the differencing attitudes to the introduction of mobile learning, and that the perception of the benefits of mobile technology on education, will be mixed.

The identification and selection of appropriate tools and approaches needs to be carefully considered (McGee & Diaz, 2007). The selection of appropriate tools will require significant amount of trial and error, on the part of the educator, and this may be very daunting to a wide number of educators. In this study the participants were all enthusiasts and earlier adopters of technology, however even they accepted that mobile learning would only be suitable in some situations and not others. In the interview, Educator B, described the number of different uses and activities he tried, to support his own teaching as well as support his students learning. Not all activities were successful; however perseverance and belief in what he was trying to do kept him trying. He stated, “I know of a large number of lectures and teachers that would have given up a long time ago. Some wouldn’t even have attempted it, just encase it failed. I suppose there is an element of worry on the educator’s side that if it fails they will look incompetent.” In this statement, Educator B, highlights a wealth of issues, such as the attitude of educators to the use of technology, the fear of failure and the perceived repercussions of this failure.

Enthusiasm of others may help develop and help promote mobile learning. As stated in Vogel, Kennedy and Kwok (2009, p. 471) “technology facilitates a community of practice for networking, sharing ideas, asking for help, and feedback (from each other)”. This fact was also shown in our own study, in table 1, and discussed in the pedagogic section, mobile learning can be used to support educators own Personal Learning Networks. Educator A, in particular, was very enthusiastic about the benefits of mobile technology to connect and develop an educators learning network. She stated, “through interaction with [other educators around the world], facilitated by [mobile devices] that are quick to access and always on and ready to use makes connections easier and possible. I use Twitter a lot to help keep up to date and share information related to education. It has been a huge part of my life”.

On the other hand, issues around privacy and access were highlighted as possible future issues, concerning the adoption of mobile learning. Privacy was, in particular, highlighted by one of the participants who implemented SMS notifications. Educator D, was rather cautious and wary about using her own personal number to send notifications. She was particularly concerned about others getting access to the number and misusing her mobile number. She stated that: “My mobile phone is personal to me. It enables people to access me anytime, this is really important now that I have had a child, therefore, the thought of someone being able to access you at anytime and being able to miss use [my phone details] was a big worry”. One solution offered by the participant was to have a dual-SIM card were the phone could automatically switch between a personal number and an institute number, she felt that having an institute number provided her with some sense of privacy.

4.2 Organisational issues

Institute support is necessary for mobile learning to be adopted in the tertiary environment. The educators involved in the study felt that their institute did not fully appreciate how mobile learning could be used to enhance learning and teaching. They found that support, especially in the form of funding, was hard to obtain when if came to buying suitable devices and services, such as data plans. Mobile learning is relatively expensive, and the purchase of suitable devices and services was often too costly for educators to cover themselves and when seeking funding from the institute there was resistance to provide funding for these devices. This issues was highlighted in Pettit and Kukulska-Hulme (2007), where mobile learning is still new and it is still unclear for tertiary institutes on the legitimacy of investing in expensive mobile technologies, when educators are still testing and evaluating the true benefit of these devices in education.

One of the educators, in this study, felt that there were a number possible reasons for the resistance of institutes in providing support for mobile learning research, (1) there is a limited amount of reliable and concrete research illustrating the benefit of mobile learning for supporting teaching; (2) there is a particular mindset when it came to mobile phones, typically mobile phones are seen as a business technology not an educational technology, therefore institutes could not see how it fit into the educational context; and (3) mobile devices are considered as personal devices it is hard to separate work versus personal work. However, as interest in mobile learning increases, and with more research studies being published, these above issues may become less of a barrier in the future.

Related to institutional support is the support provided by IT services as stipulated by the institute. Mobile learning at is essence is supposed to provide easy access, however, as discussed by the participants, IT services may not make it easy to access networks using mobile devices – typically this is for security and infrastructural limitation issues. Often certain mobile devices are not supported or access is difficult and limited. With the acceptance of mobile learning more focus is needed on providing support for educators, and students, with using and accessing services at the institute.

The polarisation of policy and attitude to technology between the institute and educators is not a new issue. In Wilson, Griffiths, Johnson, and Liber, (2007) they discuss the conflict between IT Services and educators, with their policy to limit the diversity of technology resources. Traditional IT Services approach has been to standardise the range of supported products, within the institute, with the aim of limiting the complexity of providing support. This approach has resulted in constraining the activities of both learners and staff, and as a result, staff who were interested in investigating new technologies were becoming disaffected and less enthusiastic to try new things.

4.3 Pedagogic issues

Pedagogical barriers refer to the way and the extent to which mobile technology can support the processes underpinning formal and informal learning. The results of this study highlighted the multi-functionality of the mobile devices compared to one function devices. These wealth of these tools help make learning easy and more accessible, inside and outside the classroom. Mobile devices are small, lightweight and therefore highly portable. Due to its portability, mobile devices are able to be carried around and be used for those “incidental” uses. Educator A, highlighted this aspect with the example of taking photos or video recordings of workshops or talks. This recording could be for the presenter’s benefit, such as evidence or for wider distribution to the participants or others not able to attend. A function specific device, such as Flip Video camera, could have been used however; this would need to be with her requiring preplanning, whereas her phone is always on her.

Not only is the device small and portable it contains a myriad of functions. This multi-functionality enables the same device to be used in a wide number of activities. Table 1 outlines the examples, given by the participants, of how they used the mobile device in their own teaching. Overall, it was shown that mobile technology provide a wide and rich toolset for support both educational practices and teaching. One of the main advantages highlighted in by the participants was that it enabled the utilisation of 21st century practices and supporting the 21st century learner.

Table 1. Mobile activities undertaken by the participants in this study

Function	Use	Example of how it was used by the participants
Camera	Capturing activities for later reflection	Educator B used his phone to take photos of his students teaching a class. These photos were then used in his meeting with the student after the class to help provide supporting material to his discussion with the student. Educator D and A both stated that they took photos of notes that were written on the white board that could be later distributed. This photo would provide an accurate recording of these writings.
Video camera	Capturing activities for later reflection	Educator A would video other lecturers which could then be placed on You Tube for students to view. These videos would typically cover practical activities.
Voice recording	Content provision	Educator D would record her presentation which was uploaded to the LMS so students to review. In addition, she developed small podcasts which introduced the topic for the week this would help students prepare for the class.
Web Browser	Email	Educator A/B/C would access email from the mobile device, this allowed them to stay up to date with their emails when away from the computer.
	Website access	Website were accessed for a number of uses; for quick searches – for example, to answer questions when no computer access is available,
	Access to Personal Learning Network (PLN)	The mobile device was used to provide access to expertise over a range of areas which were accessible online and used to build personal and professional support networks. For example, posting to social networks, such as Twitter was found to be extremely convenient from the mobile device. Educator C discussed being at a conference and using his mobile device to participate in the Twitter "back channel". He found this was more convenient that using his laptop since it was quicker to view open the twitter application and write short message that what would be possible on a laptop, he could even do this standing up.
SMS	Text Messages	Educator D created a SMS group which she used to send notifications to the students and made announcements, such as when there were new podcasts available on the LMS. Educator B also used SMS to keep in contact with his students and highlight interesting resources that they might like to view, for example, he sent out an SMS notifying students that there was an interesting TV program on that night that directly related to teachers in secondary education. He also sent links to interesting articles.
Applications	Wide variety of applications	A number of applications were installed to support the educators teaching, these included tools for mind mapping, note taking, blogging, and social networking applications, such as Twitter. Wikipanion (an iPhone application which allows for quick searching on Wikipedia) was also highlighted by one educator as a nice feature for those quick search actions.
Personal Information Management Tools	Calendar	The calendar function was used by the educators to keep track and manage their schedule. In particular, Educator D found this feature particularly important, since her time was at a premium she needed to manage her time well to insure that she was able to accomplish everything within her tight timeframe.
	Notes (written and audio)	Recording thoughts and capturing key details were a key aspect all the participants utilised. Voice memos in particular was found by Educator A when she quickly jotting down thoughts.
	Phone calls	Calls were typically made to coordinate meeting, Educator B was really the only educator who said that they made phone calls – this was typically to arrange meeting with schools where his students had practicums. The participants found that the device became so many other things that the fact that it could make a phone call came secondary to the other possibilities which these devices offer. (A key reason for not making mobile calls, could possibly also be related to cost. The issue of cost is discussed in a bit more detail in section 4.3 of this paper)
Sync between the device and the computer	Transfer of documents, schedule, photos, videos etc to the computer	The mobile device, used by the educators, was often used by them as a way to collect information; this information could later be uploaded to the computer for uploading, editing or storing.

4.4 Technological Issues

Mobile technology is constantly changing and evolving; however with the changing technology new platforms and capabilities are developed. With the wide range of platforms and capabilities has resulted in a wide range of mobile devices with no cross portability. One device is different, in terms of usability, functionality and capabilities, from another device. This therefore makes it very difficult to develop a consistent approach to its use with students. Related to this was the cost of devices and services. The participants in this study felt that the cost of purchasing these sophisticated mobile device, which they felt that they needed to support the full spectrum of activities they wished to perform, was out of their price range and that most educators would not be able to afford these tools without some support from the institute (this issue is further explored in the next section).

The costs of mobile services were also explored by the participants, in this study. The two educators (B and D) who implemented SMS notification, for example, needed to cover the cost of these messages from their own personal budget. In reference to this Educator D states "since my class was small the cost of sending out the messages were manageable, however, in the long run I don't think this would be feasible on my own budget". Access to the Internet while on the move was also considered as too expensive by the participants. The fact that they were not inclined to access the GPRS network mean they lost the true mobile dimension of these devices. All participants felt that this constraint did limit their interaction; however, there were ways to work around this, such as accessing wireless networks, when available, which limited the impact of this constraint.

Alternatively, as mobile technology advances more usable devices are being developed. Devices such as the iPhone have been highlighted as a device that overcomes barrier shown by other technology. The iPhone and similar technologies offer a new way of interaction that are more tactile interaction that seems to provide a more organic interaction. One of the educators in this study, gave the example of giving the mobile device to one of her more technophobic of her students, she states, "after some initial instruction the student was taking photos and video, however the really exciting thing as [the student] was actually excited about the process, and even showing how to [that photos and video] with the other [students in the class]". The ability of mobile technology to combat existing negative attitude towards and resistance to ICT has been explored in a number of studies, in particular, in Attewell (2005), she discusses a project with mentor working with a group of displaced young adults studying ESOL, that there was a significant difference in attitude and eagerness to use ICT technology after the participation in the mobile study.

5 DISCUSSION

This paper discusses the issues surrounding the use of mobile technology in the tertiary sector. The study outlined five themes which were identified from interviews with four educators. The aim of this study is not to represent all possible views of educators in the tertiary environment but rather provide some key aspects that were considered by these educators as important factors in mobile learning. Based on this analysis we were able to determine what key aspects best facilitate and hamper the introduction on mobile technology adoption in education. Based on these key aspects these results could be looked at as being either enablers or barriers to the adoption of mobile learning, therefore based on this we could further refine the results to represent the perceived strength and weakness of mobile learning.

As highlighted in this study the key strengths of mobile technology in education, is that it:

- Offers a wide number functions in one device
- Always on hand – allows for incidental use
- Portable – the small size means that it can fit into the pocket
- Wide ownership - most people have a mobile device of some sort
- Able to provide a new way of learning that is unique or provides more convenient access
- Anywhere access - is available anywhere not tied to one location
- Enables access to content/ experts/ information/ support anytime
- Mobile technology has a coolness/ hype/ interest factor

On the other hand, issues that limit the

- Physical constraints – size and input
- Cost of devices and services
- Variety of platforms - no standard
- Not all students have appropriate devices
- Variety of platforms and capabilities of mobile devices
- Not all learning/teaching activities are suitable for mobile learning
- The benefit to education not fully identified
- Implications on pedagogy

By highlighting the strengths and weaknesses of mobile technology, to support teaching, we can thus provide an insight the enablers and barriers of mobile learning. These enablers and barriers are outlined in Table2.

Table 2. Barriers and Enablers to the adoption of mobile learning

Key Factors	Barriers	Enablers
Pedagogical	The impact on existing pedagogy Suitability of the tools to support the desired interaction	Enables a new way of support and learning which can better support some processes Makes it easier to access and use social software to support the teaching processes
Sociocultural	Ethical implications Student and staff resistance Staff expectations and prior experiences	Better providing for the change in the student demographics the demand for new ways of learning and teaching Able to overcome existing barriers in terms of attitude to ICT Flexibility of space and time Wide range of tools and opportunities Current high ownership of mobile devices
Organisational	Costs, funding and ownership Institutional strategies and objectives Institutional constraints on use of technology Teachers' skills and training	Institutions do not need to provide all the tools
Technological	Technical support Interoperability between devices Varity of devices and speed of technology advancement Ownership of devices Usability Institutional hardware and infrastructure	Enables incidental use New technology provide new opportunities to support learning and teaching Provides a rich toolset that can be utilised to support a wide range of activities

6 CONCLUSION

The aim of this paper, was to provide an insight into the use and perception of tertiary educators to the use of mobile technology. Mobile technology offers the ability for spontaneous, immediate, and more accessible access. The benefits of mobile learning are significant and real to educators and students, however for the true potential of mobile technology in the tertiary sector to become apparent there are still a number of key barriers that will inhibit the adoption of mobile learning. Not all of these barriers are able to be resolved by the institute or educators themselves. These barriers should not result in mobile learning being written of rather to highlight the issues that need to be taken into consideration when looking at the introduction of mobile learning. In addition, cooperation between the institutes and educators is necessary to allow more and ongoing investigations into how they mobile technology can be harnessed in the particular educational context.

The limitations of this paper are that it only provides a glimpse into the opinions of a very small group of educators – all of which are early adopters of technology. Further exploration with a wider range of participants is needed, however, the aim of this paper was only to provide an initial look at what aspects will influence future adoptions. These are the aspects that are needed to be addressed before any significant progress can be made into the adoption of mobile learning and it introduction into the teriary educational context.

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PODCASTING FOR MOBILE LEARNERS: USING UBIQUITOUS TECHNOLOGIES TO ENHANCE LEARNING IN LARGE CLASSES

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Abstract
Although the use of podcasts is increasingly becoming common in education, its potential to support mobile learners with varying access to the Internet has not been exploited. This paper reports on a project in which educators with no previous podcasting experience used inexpensive devices to create podcasts to support over 400 first year students enrolled at a higher education institution. An open source learning management system (LMS) was used as a podcast server, students used their limited time when on campus to download podcasts to low-cost ubiquitous playback devices to listen to offline, and used their mobile phones to post questions and receive answers on issues that arose from listening to podcasts. Drawing on the results based on an ethnographic study, the paper concludes that podcasts enhanced learning in a large first year class by exploiting technologies that educators already had (a dictaphone), infrastructure the institution already had (LMS and broadband Internet connection), playback devices students already used for their personal entertainment (MP3 players and iPods), and mobile phones every student already owned.

Keywords
Podcasts; Reflective Learning; Learning Management Systems; Lecture Casting; Course Casting

1. INTRODUCTION
Podcasting is derived from the term broadcasting and the iPod (Matthews, 2006). It is a technology that allows audio and or video content from one or more pre-selected feeds (channels) to be automatically downloaded to one's computer as it becomes available, then later transferred to various types of companion media such as iPods and MP3-capable mobile phones, for listening to at a convenient time and place, or "on the move" (Chan, Lee & McLoughlin, 2006). It stems from the merger of three technologies: Really Simple Syndication (RSS), portable Moving Picture Experts Group-1 Audio Layer 3 (MP3) players, and blogging (Price, Gay, Searl and Brissenden, 2006). The technology is relatively new within the educational sector and more so in developing countries, like South Africa, where resource scarcity such as broadband continues to be a challenge.

A useful point of departure for this paper is the philosophical words of Thomas Carlyle (1795-1881): "…in books lies the soul of the whole Past Time; the articulate audible voice of the Past, when the body and material substance of it has altogether vanished like a dream." Unlike books, podcasts can be produced and used by anyone at anytime with a relatively low budget and therefore exceed the effect of books as espoused by Thomas Carlyle. In the era of Web 2.0, Carlyle's phrase would read: "…in podcasts lies the whole curriculum; the articulate audible voice of lecturers, when the lectures have long stopped and learners are mobile and distributed." In large classes and where some learners are taught in a language other than their mother tongue, students may struggle to understand presentations immediately, and podcasts provide an opportunity to re-live a lecture thereby enhancing learning. This paper reports on the use of podcasts in a large first year class where learners were mobile between dispersed class contact sessions during which time their access to the Internet was limited. It was against this background that we began exploring ways of leveraging the high broadband access learners have when on campus and the low cost off-line mobile devices they owned. Thus this paper reports on the blending of a Learning Management System (LMS) that acted as a podcast server, mp3 players and mobile phones both owned by learners. The paper also illustrates an implementation model for integrating podcasts to scaffold learning.

The rest of the paper is organized as follows: an overview of prior work leading into this project is outlined, followed by a discussion on the types of podcasts and learner mobility. Following this is a critical literature review of podcasting and this leads to a description of reflective learning that is mediated by use of podcasts; a case study is then discussed and both observations and findings presented. Finally, a discussion of findings is presented and it ends with a conclusion.

2. PREVIOUS WORK
Between 2005 and 2008, over 4300 students at the University of Cape Town used an anonymous knowledge-sharing tool called the Dynamic Frequently Asked Questions (DFAQ) (Ng'ambi, 2005; Ng'ambi and Johnston, 2006; Ng'ambi and Brown, 2008; Ng'ambi and Knaggs, 2008; Ng'ambi and Goodman, 2008). DFAQ empowered shy learners or learners with low self-esteem who usually remained silent or felt dominated during face-to-face sessions to use Short Message Services (SMS) to ask and receive answers to questions posted anonymously to a shared environment. One of the strengths of DFAQ lay in aggregation of individual postings to provide faculty with formative evaluation about a group of learners. This was particularly useful in large classes where such information was difficult to harvest. Ng'ambi and Brown (2008) report on how the use of DFAQ in large classes enabled access to summative information, which impacted on the curriculum. It follows when learners listen to podcasts using off-line devices such as mp3 players and know that they can use mobile phones to SMS/text questions about a podcast, an interactive engagement with podcasts is created. In our current

work, we are investigating ways that learners can contribute audio feedback or commentary on a podcast via the mobile phone.

The lack of balance in knowledge sharing led to segregated knowledge spaces based on a few voices that have both access to technology and whose medium of instruction is their first language. In the case of other students, there was a continuum of 'loss of voice' as learners traversed between knowledge clusters. When learners came to class, they transitioned from clusters of power (peer clusters) to a space where they felt powerless (suppressed voices) as co-producers of knowledge. Learners with dominant voices in class also transitioned from clusters of equals (peer clusters) to clusters of power (dominant voices). Thus, learners were continuously moving between clusters (cluster mobility) and were mindful of the changes all the time. The coupling of podcasts with a mobile phone feedback loop equalized participation in class, and enhanced class interaction and leveraged the limited time students had access to broadband Internet connectivity.

Other findings from prior DFAQ research reveal that some students could not engage in face-to-face discussions including asking questions because they needed more time to understand presentations or discussions, as English was not their mother tongue. For these students the delay in understanding and formulating a reflective response meant that they needed a reflective space before they could constructively engage in discussions. In 2009, one of the features of DFAQ, the anonymous Question & Answer (Q&A) functionality, was incorporated in the LMS. The LMS used at the Institution was Open Source Learning Management Software called Sakai (locally branded as Vula). Thus, the integration of anonymous Q&A (which supported both incoming and outgoing SMS) into Vula augmented a podcasting tool of Vula to effectively support mobile learners. Both podcasts and vodcasts (video podcast) were uploaded into Vula. Learners used the high broadband connection at the University to download podcasts onto mobile devices, in particular mp3 players and mobile phones for listening to when offline. This paper explores an integration and use approach of podcasts based on the intersection of an Institutional LMS with broadband connection and low-cost ubiquitous devices that students owned on one hand, and learner mobility between high access to Internet connectivity on campus, to no access to Internet when away from the Institution. The model to leverage the strengths of these apparent paradoxes is discussed.

3. PODCASTING AND LEARNER MOBILITY

According to McGarr (2009), the three reasons cited for using podcasts are: making learning more flexible, increasing the accessibility of learning materials and enhancing students' learning experiences. Using podcasting to provide extra resources for students to use is an idea that appeals to many. However, the difference between the assumptions about devices that learners use and the location of their listening, and the actual devices used and where listening happen, could make the difference between successful or unsuccessful integration of podcasting in education. One of the first institutions to offer podcasts was Duke University. All first year students enrolled in August 2004 were given an iPod, which it was hoped would be used for content distribution, classroom and field recordings, study support and file storage and transfer (Duke University, 2005; Earp, Belanger & O'Brien, 2006). Duke University is an example of an even environment where both the Institution and learners had similar broadband access and synchronisation of iPods with the institutional resources could theoretically happen anywhere at anytime.

In 2005, the University of Washington implemented a podcasting pilot which aimed to give students "any time, anywhere" options for reviewing lectures which were previously made available in the form of analog recordings. Aldrich, Bell and Batzel (2006) state that at the University of Washington podcasts were used to provide students with the ability to engage in lecture review and enhance their understanding of what is covered during lectures. The University of Washington used a system in which the recording, encoding and publishing process was fully automated, with lectures being ready for download a few minutes after the lecture. The University of Washington project was premised on the assumption that learners had broadband access anytime anywhere. According to Bell, Cockburn, Wingkvist and Green (2007), the other attraction podcasting holds for education is the potential to broaden the times, places and manner in which students study and learn. It has been proposed by Salmon and Nie (2008) that podcasts can be used to create informal learning spaces which can be used to support the transfer of knowledge. Bell et al. (2007) state that the main benefit podcasts offer students is the ability to listen to course related material at their convenience. This convenience presuposes that learners have access to a fast Internet connection all the time and can therefore choose when to listen to podcasts. Bell et al. (2007) add that the most common application of podcasting at universities is to provide students with traditional lectures as a podcast. However, pedagogical uses of podcasts require careful thought and planning if podcasts are to enhance a learning experience. This is echoed by McGarr (2009), who suggests that pedagogy influences the way podcasts are used and use is in turn affected by the views held by both staff and students.

3.1 Lecture Casting

One of the benefits of podcasting lectures, according to Hurst and Waizenegger (2006), is to complement existing teaching services offered in higher education. Hurst and Waizenegger identify four ways in which lectures can be delivered to students in the form of a recording, namely: *podcasts* or audio-only files in MP3 format, *enhanced podcasts* which contain other media in addition to audio and are usually synchronised with visual aids such as PowerPoint slides, *video podcasts* or *vodcasts* in which audio and video files are synchronised for playback and *screencasting*, a special type of vodcast containing a video recorded via screen-grabbing.

Although podcasts complement existing teaching services, they lack mechanisms for facilitating learner feedback especially if learners listen to podcasts using off-line devices. Audio-only podcasts are less resource intensive and more portable to many low-cost mobile devices. In resource-constrained environments, audio-only podcasts are more effective both in terms of production and use.

3.2 Course Casting

Course-casting is by no means the only way of utilising podcasting in education. Podcasts can be used to provide supplemental material to students, for use either before or after a lecture (Frydenberg, 2006; Miller 2006; Deal, 2007). Supplemental podcasts can be used to restructure class time and to brief learners on a task or a lab session. Miller (2006) gave his class Precasts before each class, which students referred to afterwards to fill out and scaffold their note taking.

Bell et al. (2007) report that despite the wide range of possible applications, the most commonly used podcasting approach in tertiary education is course-casting. Salmon, Mobbs, Edirisinha and Dennett (2008) identified seven technical features of podcasting which support learning namely: the ease of capturing content using cheap equipment, free software and tools, free and easy distribution mechanisms via VLE, easily accessible by students, students choice of using a playback device that they already own, no technical skills are needed as the person using a podcast is already familiar with their playback device, podcasts are easy to use allowing for flexibility and content can be contributed by anyone with sufficient knowledge, students included.

3.3 Student-Generated Podcasts

The final way in which podcasts are used in education is in the form of student-produced podcasts (Frydenberg, 2006; Hurst & Waizenegger, 2006). At Charles Sturt University, students were encouraged to produce podcasts for extra credit (Chan and Lee, 2005). In the process, students learned the technology behind podcasting as well as how to use it effectively as a tool to communicate their ideas. At the University of Cape Town's Centre for Educational Technology, students in a postgraduate programme use low-cost offline devices to record audio for uploading when they have access to broadband Internet when on campus. They download peers' podcasts to listen to when offline and use anonymous SMS to post questions and receive answers through the Q&A tool with the LMS. Cane and Cashmore (2008) add that students involved in the podcast production process acquire transferable skills including team work. This is important in instances where students are required to work on group projects, as is the case with Information Systems.

4. CRITICAL REVIEW OF PODCASTING

4.1 Strengths

The strengths of podcasting are many and well documented (Bell et al. 2007; Hurst and Waizenegger, 2006; Lane, 2006a/b, Tynan & Colbran, 2006). Lane's 2006 evaluation of podcasting at the University of Washington shows that there are several benefits to using podcasts in supporting student learning including: a convenient access to course material, help in catching up when students miss class, help with homework and exam preparation as well as clarifying concepts missed in class.

Podcasts give students an easy way to access course material. This is because they can choose which lectures they want to listen to again. Students can also scan the files, skipping to sections of particular interest to them. They can also listen as many times as they wish to. Tynan and Colbran (2006) report that podcasts give students the ability to shift time, and control when to replay the recordings, a major advantage for time constrained students. Since podcasts can be synchronized with other media files, they give students access to learning material which is multimedia in nature. Salmon & Nie (2008) suggest that providing multimedia resources, in non-traditional formats can scaffold the meaning-making process, leading to more effective learning.

Podcasts can be used to clarify concepts discussed during lectures. As students take down notes during lectures, they may miss points which the lecturer stresses. As they can access the podcasts directly on computer or transfer those to a playback device of their choice, students can revise as and when they need to. Podcasts also help students revise for tests and assignments as they can be used to fill in the gaps and correct notes which were hastily taken down during lectures. Podcasts thus serve as outlines of the important concepts a lecture is based on and can therefore be used as a start from which students can build up their understanding. This also means that students struggling with language issues have an opportunity to understand a lecture which they would otherwise not have understood during the face-to-face session.

Knowing that podcasts are available can make students concentrate more in class, as they don't have to make notes in addition to listening and taking part in discussions. Podcasts are also a valuable resource that can be used to catch up when one misses a lecture. Some students will have reasons for them to miss lectures, for example illness. In such instances podcasts give such students something to fall back on. Also podcasts are able to meet the different needs/circumstances of diverse groups of students. This according to Fernandez, Simo and Sallen (2009), is because podcasts are able to increase the range and type of learning experiences students are exposed to.

4.2 Limitations

Despite their strengths, podcasts also have limitations. Campbell (2005) states that others argue that audio is a poor channel for conveying information because a learner cannot control the pace and is therefore at the mercy of the speaker's tempo.

The EDUCAUSE Learning Initiative (2005) gives some downsides to podcasting, one of which is they are not designed for two-way interaction or audience participation. The article further states that faculty who may wish to record their lectures or other instruction for podcasts may need some training, both in handling an audio-only medium and using the technology. This is important, especially if the teaching staff will be responsible for producing and publishing the podcasts themselves. Training is also important in order to gain an appreciation of the technology behind podcasting, as well as how to use it effectively as a tool to communicate ideas. The lack of a two-way interaction is reason our approach incorporated the use of mobile communication to encourage interaction that is podcast triggered.

Bell et al. (2007) identify further disadvantages including the hypo attention of the listener due to environmental distractions and the material on the podcast. This means the listener cannot concentrate, as there is competition for attention between the podcasts and the environment, which reduces the benefit that can be derived. Anecdotal evidence shows that most of our students study with music in the background and multitask with mobile devices in ways previous generations were not able to. This suggests listening that podcasts might not be as harmful a distraction as it might appear.

Frydenberg (2006) recognizes another limitation of podcasts with regard to the ability to search through the file. One is not able to search the file for a key term in order to listen to a particular section one wishes to review only. One has to listen to the whole file, which may put off those who want to listen to specific segments or scan the whole file to get what they want.

5. MEDIATION OF REFLECTIVE LEARNING

Learning is a reflective process and without reflection, learning cannot take place. However, reflecting on say a reading is a process of interrogation of the text through a series of questions. In essence, the reader interacts with a distant author and attempts to make meaning in the context of a reader. The context of a reader is influenced by the task at hand and the social structures on a reader's mind. It means that reflection does not happen in a vacuum; the reader brings what they know to understand what they need to know. Both when reading an article and listening to a presentation, a learner is in a continuous state of linking between the known with the need to know. An event such as listening to a lecture is a useful trigger for reflection. However, there is no time for reflection during a lecture. Learners either take notes to help them reflect on a lecture later or are busy trying to make sense of the presentation. Thus facilitating reflection through podcasts has the potential for enhancing the learning experience (Ng'ambi, 2008).

A lecture is recorded; audio files are converted to common formats such as mp3 and uploaded on to the LMS. Using tools like iTunes, learners subscribe to the LMS podcast feed, synchronise their iPods or mp3 players and the podcasts are downloaded to the mobile device. Once on a mobile device, learners are able to re-live a lecture at their convenience and reflect. During such reflection, learners are isolated from both peers and teaching staff. Should a need arise where they need to ask questions, the mobile phone is used to SMS the Q&A tool in the LMS.

6. CASE STUDY DESCRIPTION

The study site was an undergraduate course in the Faculty of Commerce at the University of Cape Town. This course is compulsory for all first year students in the Faculty and is structured as follows: students choose to take the course in either first semester or second semester. The aim of the course is to equip future graduates with core skills expected of 21st graduates entering the world of commerce upon graduation. These skills include using, controlling, designing and evaluating information systems.

The study was conducted during the second semester from July 21 to October 14. The lecturers recorded their lectures, and the Research Assistant edited and uploaded the audio files on the course site on the LMS. It was decided that putting the podcasts on the course site was the easiest way to ensure that all students had access, as this would complement the other resources already available to students via the same platform. These include lecture notes and the PowerPoint slides used by the lecturers. Publishing the podcasts on the course web site was also influenced by studies conducted elsewhere which reported that students used the podcasts together with other online resources, including lecture notes and PowerPoint slides.

Students in this course were from diverse backgrounds, with varied levels of preparedness for higher education, owned mobile phones and other forms of mobile media players. The total number of students was 411. Most of the students commuted to campus from home and had no access to Internet when away from the campus. The time spent on campus needed therefore to be optimised and this involved downloading resources to devices for reading off-line. For these students, their mobility was between home (without Internet connection); buses, campus, computer laboratories and classroom. The time for socialisation and engagement with peers was also limited. It was in the context of the above challenges that we saw an opportunity to using podcasts to support mobile learners who traverse high broadband Internet connectivity environments (campus) to zero connectivity (home).

7. METHODOLOGY

The study adopted an Action Research approach and was conducted using an ethnographic method. A Research Assistant attended all the lectures, assumed responsibility for editing the audio files, converting them to MP3, uploading them to the LMS, and interviewing all lecturers. The recording of lectures was not automated and each session was recorded using a handheld digital recorder. Some of the post-recording processing conducted involved cleaning up the audio file by removing class announcements and undesirable noise. It also included compression of the file into the more usable MP3 format. The podcasts were made available on the LMS the same day of the lecture, except in a few cases when the files were uploaded the following morning. Two types of recording were done: a scheduled live lecture and a practical briefing. The practical briefing involved details of what students were do do in the lab that week. A total of six lecturers gave lectures over the course of the semester. Five lecturers agreed to have their lectures recorded. None of them had any prior experience with using podcasting to support student learning.

Consistent with technical guidelines (see Section 3.1), a basic dictaphone was used to record lectures, and the institutional LMS used as a podcast server, and learners either downloaded podcasts directly from the LMS or used podcast aggregators such as iTunes or SharePod.

Although the primary data was collected using a variety of means, including student survey, student focus group discussion and interviews with the principal lecturers, for the sake of brevity, these findings are not presented in this paper. The web server logs, which provided data on use of podcasts based on the frequency of download by users, form the basis for the discussion that follow.

8. OBSERVATIONS

It was assumed that all the students who would use the podcasts would access them via the course site, hence the decision to put them up there. The unexpected however happened, with some students choosing not to use the course site to access the podcasts. They used podcatchers or RSS feeds. Though this was a small number of students, it is significant in that it may indicate that some students have used podcasts before for non-academic purposes. This was unexpected because one has to subscribe to an RSS feed via a podcast aggregator (software that checks podcast feeds at regular intervals). It also gives weight to the use of podcasts in education, as some of the students are already familiar with the technology.

Since some students accessed the podcasts via RSS feeds, two sets of logs were generated, whose pattern of access is shown in the table below.

Access via RSS feeds	Access via course site
44	242

Table 1: Number of users by mode of access to podcasts

The total number of students who accessed the podcasts adds up to 286, more than half the total number of students registered for the course. This means that about 69.6% of students registered for the course accessed the podcasts at least once. Access via RSS feeds and via LMS accounted for 10.7% and 58.9% respectively. Lee, Miller and Newham (2008) put forward several reasons for the lack of widespread adoption of RSS feeds by students, including the use of multiple personal computers, which limits the use of RSS feeds. This could be the case, especially for our students, who regularly move between high broadband Internet connectivity environments (campus) and zero connectivity (home).

An analysis of the web server logs indicated that the podcasts were downloaded quite frequently, though this depended on which resource was accessed. There were a total of 41 files. Some files were downloaded more than once by the same user, which indicates that students do not listen to each and every lecture and that they might listen to some lectures more than once. Additionally, students may not be downloading and keeping the files for later reference, but rather download as and when they need to use them. This is inferred from the number of times the podcasts were accessed that is more than the total number of people who accessed them. This was particularly significant given that the mobile devices such as MP3 players have limited storage capacity. It could be inferred that students may have 'carried' on the mobile device only podcasts that they were busy with, given that they could return to the LMS to download some more, adding weight to the findings by Lee, et al (2008).

For the LMS log-ins, the number of times each user accessed the podcasts is summarized in the table below.

Less than 5	Between 5-10	Greater than 10
85	115	42

Table 2: Number of times users accessed the podcasts

This represents percentages of 35.1%, 47.5% and 17.4% for access less than five, between five and ten, and for access greater than ten respectively. It should be noted that the logs were obtained just after the last lecture of the semester. Varying download patterns may be observed at different times, say just before the practical or theory exams that were scheduled for October 27 and November 10 respectively.

Accessing the files via LMS was easy as students already used the course site to access other course materials and were able to navigate their way through with relative ease.

9. FINDINGS

Analysis of the data collected suggests that students found podcasts useful and wanted them made available for other courses as well. From the download patterns, a significant number of students used the podcasts, with 68% of students registered for the course accessing them. Some students said they used podcasts for learning in high school, while others were not familiar with the technology. It would be useful to remind the students about the podcasts as some report not being aware of the availability of podcasts at the time of administering the questionnaire. Some suggestions by lecturers on improving the podcasts made include; having video in addition to audio, recording small segments of the lecture as opposed to all of it thereby making the files smaller, less time consuming and easier to download, noting the slide number at which the lecturer is at specific points of the recording and making the sound clearer. Some students felt that the podcasts need video in order for them to be effective and so did not use the audio files, others used the slides and textbook only and some students forgot about them while others never thought of using them.

Despite the specified need for improvements, some students asked for podcasts not to be discontinued as they were of much help to them. Some of the ways in which the podcasts were found to be useful in learning include enabling students to gain a better understanding as they reviewed what was said by lecturers, an effective way of grasping concepts at one's own pace, while others found them helpful when classes weren't specific.

Lecturers did not find it inconveniencing to record their lectures. This is quite significant as lecturers' needs have to be taken into account when introducing a new technology or revising an existing way of delivering material to students. From the lecturers' point of view, the principle reason for using podcasts is to give students additional resources that they can use for study and reference purposes. Using the latest technology for learning purposes is meant to give students a choice in what resources they use to meet their needs. Lecturers also report that the time spent on consultation and lecture preparation is not affected by the availability of podcasts. This is significant because as a new technology is adopted and mastered, there is a trend towards taking time away from lesson preparation and student consultation as lecturers update their skills and learn how to use the technology.

10. DISCUSSION

10.1 Challenges of Producing Podcasts

The biggest challenge faced was the inability of the microphone to pick up the students' voices when they were speaking. This caused difficulty in retaining portions where students asked questions or responded to lecturers' questions.

The initial plan was to break down the audio files into smaller ones a specific topic during the lecture. This would have made it easy for students to find what they were looking for and would have given them the advantage of downloading smaller files. But because the lecturers more or less covered a topic or part of a topic in one class, it seemed pointless to do so. Also, after processing, the length of the audio was significantly reduced, making it reasonable to put it up as it was (about 25 to 35 minutes long). Filtering out outside noise also posed a significant challenge. It was easy to cut out noises made when the lecturer was not speaking; otherwise it was left there.

10.2 Recording equipment

A simple inexpensive digital recorder was used to record lectures. The recorder was easy to use as well as small enough for the lecturers to carry around in their pocket. It had both an inbuilt and external microphone. The external microphone was used to get better sound quality and to ensure that the lecturers' mobility was not restricted to the vicinity of the recorder.

Some of the minor technical problems experienced were accidental switching off the recorder as the lecturer moved around and interference with the sound system in the venue, which resulted in poor sound quality. To make the recording process more reliable and have better quality, it is suggested that an automated recording system be invested in. The system should be one that a lecturer can activate at the press of a button once they are ready to start the lecture. As none of the lecturers had prior experience with podcasting, an automated system would make recording lectures easier and more attractive for them.

Since the files were uploaded as MP3, it would make more sense to use a recorder which records in MP3 format. The MP3 format is favoured because many inexpensive playback devices already in the students' hands support this format.

There was improved attendance, especially at the practical component of the course. Previously, this component suffered declining attendance resulting in poor student performance in the exam. However, with a revamp of the course and the introduction of podcasting, students were inclined to attend the lectures because according to them:

> *The podcasting worked very well as I was able to construct notes from the lectures after the lectures were finished.* (extracts from 2009 course evaluation)

In addition to these qualitative comments, a quantitative survey indicated that 7% of the students found podcasting an excellent support system to their learning; 14% stated it was good; 48% said it was average; 16% felt it was poor and the 14% unacceptable.

10.3 Recording and Editing Audio Files

The recording process was relatively simple. Lectures were recorded every lecture day. After the lecturers recorded their class session, the file was downloaded from the recorder onto a desktop computer for post-recording work. The file was first converted into MP3 format. The file was then edited and uploaded onto the course site on the university server. During the editing process, the files were tagged, making them easy to identify. Editing was quite time consuming, as others discovered before (Wolff, 2006). A forty-five minute audio file required between one to two hours editing time, depending on how much editing was needed.
The conversion and editing software was downloaded for free off the Internet. The general idea was to reduce the size of the files to enable students to download on small-cost playback devices. The advantage of low-sized files was that the few students with iPods were not privileged at the expense of those who did not.

11. FUTURE WORK

We are currently investigating whether the use of podcasts in a large class has any impact on academic performance. To explore this question, we are particularly interested to know the podcast usage patterns. For example, how do students select which podcasts to listen to (agency)? And when do students listen to podcasts most (e.g. pre-lecture or post-lecture; pre-practical or post-practical; pre-exam or post-exam). Does this usage pattern differ between students? What is the usage pattern of students whose mother tongue is different from the language of instruction?

12. CONCLUSION

In conclusion, the paper has shown how an inexpensive recording device was used for lecture casting to an existing institutional LMS. Students exploited the broadband connection available at the Institution to download resources including podcasts to low-cost playback devices (MP3 players and/or mobile phones). Queries that arose from listening to podcasts while mobile were sent as SMS to an anonymous Q&A tool within the LMS. The paper has thus illustrated an approach for leveraging ubiquitous low-cost technologies with well-resourced institutional technologies to support a large class with varied access to technologies beyond what the institution provide.

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AUDACITY- open-source software for recording and editing audio (needs the encoder LAME 'libmp3lame' to export edited files). http://audacity.sourceforge.net

JODIX- open-source software for converting audio from WMA to mp3 format. http://jodix.com

LAME http://www.spaghetticode.org/lame/
Alternatively, type the name of the software you want in a search engine and it will bring up several options for you to choose from.

Mobile Learning in the Italian University, a Survey about Students' Readiness for Mobile Learning

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Abstract
In this paper, after a review of the literature concerning mobile learning experiences in the universities, with a special focus on the Italian situation, we will present the main results of our work. We developed a structured interview concerning mobile devices, e-learning and mobile learning, with particular attention devoted to the implicit and explicit readiness to do mobile learning. We administered this interview to 174 Italian university students.

Keywords
Readiness for mobile learning, University, Italy.

1. INTRODUCTION

Postman (1995) says that technological change is not additive but ecological. A new technology does not merely add something; it changes everything (Postman, 1995). As Rheingold (2004, p. 1) underlines that "the mobile telephone has quickly, profoundly, and unexpectedly altered many aspects of human life -- social, economic, cultural and political". "Wherever one looks, the evidence of mobile penetration and adoption is irrefutable: cell phones, PDAs (personal digital assistants), MP3 players, portable game devices, handhelds, tablets, and laptops abound. No demographic is immune from this phenomenon. From toddlers to seniors, people are increasingly connected and are digitally communicating with each other in ways that would have been impossible to imagine only a few years ago." (Wagner, 2005, p. 42). In fact, mobile phones and many other mobile devices have become part of our everyday life; consequently it is not strange that people integrate mobile computing into learning to make learning more accessible and portable. "New and emerging pedagogies have harnessed the power of information and communication technologies, bringing dramatic change in the educational landscape, transforming the breadth, depth and opportunities for learning" (Williams and Goldberg, 2005, p. 725). In Salmon's opinion (2004), mobile learning is more than a mere moment of technological fascination: it is clearly identified as the fourth generation of the electronic learning environment, where "the value of deploying mobile technologies in the service of learning and teaching seems to be both self-evident and unavoidable." (Wagner, 2005, p. 42). In light of international literature in the field of information and communication technologies (ICT) in education, the university cannot ignore the mobile information and communication technologies and cannot refuse to involve these technologies in the learning process doing mobile learning. But are our university students, those called by Prensky (2001) "digital natives", really ready for mobile learning? Are Mobile devices already part of their everyday learning process? The frequent use of mobile devices in everyday life does not mean that people - students and teachers - are ready for mobile learning and teaching.

In this paper, after a review of the literature concerning mobile learning experiences in the university context, with particular attention to the Italian situation, we will present the main results of our survey about readiness for mobile learning of our university students. In light of previous studies about students' readiness for mobile learning (Trifonova et al., 2006; Corbeil and Valdes-Corbeil, 2007; Jacobb and Issac, 2008; Peters, 2009), we developed a structured interview concerning mobile devices, e-learning and mobile learning, with specific attention devoted to the implicit and explicit readiness to do mobile learning. We administrated this structured interview to 174 Italian university students.

2. MOBILE LEARNING AND UNIVERSITY

At the international level, as emphasized by several prominent scholars in the mobile learning field (Kukulska-Hulme et al., 2008), mobile learning projects in the university context are now less mature and more experimental than those in the school context (elementary, middle and high school), although the support of wireless networks for students equipped with laptops has increased a lot in the universities worldwide. Projects in the university have mainly focused on supporting the involvement and active participation of students within and outside the university campus, however, unlike what happens in schools, mobile learning projects related to the university context do not seem to have considered enough:

- the connection between the lessons in the classroom and the world outside the classroom;

- the attempt to involve students who are not in the classroom.

The approach is more focused on providing learning support for students wherever they are, rather than locating students in other places than classrooms. Kukulska-Hulme and her co-authors (2008) speculated that this may be due to the less directive nature of university education, compared to education in schools. To give a picture of the quantity and the diversity of mobile learning projects in the university, three initiatives based on SMS are representative:

- *Study- Link* (Naismith, 2007) analyzes the possibility of a service "from e-mail to text messages" for the communication between administrative staff and university students. The facilitation of improved communication and interaction between staff and students in the university environment via mobile technologies has been considered also by Divitini, Haugalokken, and Norevik (2002), Beale and Jones (2004), and McGovern and Gray (2005), with Field (2005) considering the blended learning environment. The delivery of appropriate administrative support as well as timely course content is a key element to engagement in the increasingly competitive communication environment, where 'information overload' or a high cognitive load (Frohberg, 2004) is of real concern.
- *TVremote* (Bär et al., 2005) explores the use of SMS in the classroom for students to send feedback to teachers.
- *Pls Turn UR Mobile On* (Markett et al., 2006) explores the use of SMS in the classroom to promote interactive paths proposed by the students themselves.

In these three projects researchers used the personal mobile phones of the students and the mobile networks that already exist, but built specific applications to manage and control the correspondence-based SMS. The costs incurred during the project were self-financed internally by the projects themselves, but the cost is usually highlighted as a barrier to the spread of learning activities based on SMS.

Other projects have targeted students in courses on practical activities, concerned students in internships in medical fields. For example, the project *myPad* (Whittlestone et al., 2008) addresses the issue of supporting the active involvement of university students outside the university. In particular, the project aims to support veterinary students during clinical practice and provides a Web accessible tool for clinical activity through mobile devices. Device capabilities and the functionality of the instrument allow students to take notes and write reflections on cases, save graphics and audio data, and link these or other relevant resources to their notes.

Duke University (URL: www.duke.edu) made headlines when in 2004 it issued iPods to its first year students (Associated Press, 2005). Seven diverse examples have been provided concerning the use of the iPod (Duke, 2004); however, as observed by Cochrane (2005), merely providing technology such as iPods does not guarantee that it will be used in an educational way (Bugeja, 2005). The final evaluation report of Duke's implementation has given rise to the development of the Duke Digital Initiative (Duke, 2005), which focuses on experimentation, development, and implementation of digital technology in an academic environment.

Taking Duke's example, Drexel University's School of Education has provided iPods for their 2005 intake. William Lynch, director of Drexel's School of Education, has rationalised the decision: "Rather than resisting a popular technology because it's popular, we want to embrace that as a way to be more effective in communicating." (Perlman, 2005) Following the same direction, Virginia Tech College of Engineering (URL: www.eng.vt.edu/) became the first public institution to require all students to purchase a tablet PC beginning with incoming freshmen in the fall of 2006.

In the university context Thornton and Houser (2004) realised three projects in Japan using mobile phones to help university students in the English learning path. Given the perceived popularity of the devices (100% of 300 students polled owned a mobile), the researchers wished to assess their educational potential. When Thornton and Houser (2004) suggested that students receive information about their classes via mobile phones, the cohort reacted positively, perceiving this to be an important potential use of SMS technologies.

In Italy mobile learning is not yet very common in the education context in general, and the experiences of mobile learning in the Italian universities are really few. Among these few mobile learning experiences there is the experience of the Università di Napoli with the Federica platform (URL: http://www.federica.unina.it/il-progetto-federica/spot-ita/). The students at the Università Federico II di Napoli, through their iPhone and iPod Touch, can download on their mobile devices several podcasts (300 courses and 5000 lessons) and can access the Living Library and the Virtual Campus, a three-dimensional reconstruction of the Università Federico II di Napoli. Starting from 2008 the students of the Faculty of Medicine and Surgery of the Università degli Studi Aldo Moro can download video-audio-podcasting through their mobile devices, such as iPhone and mobile phones.

The Università degli Studi di Milano-Bicocca (URL: www.unimib.it) has developed several pilot mobile learning experiences, before using its own platform and after the moule platform (URL: http://moule.pa.itd.cnr.it/). In these experiences of the Università degli Studi di Milano-Bicocca the students were using the mobile devices given by the University and not their own mobile devices.

The Università Guglielmo Marconi (URL: www.unimarconi.it/) is trying a new teaching methodology called Integrated Learning System which includes the provision of courses by using the combination of e-learning (PCs), mobile learning (mobile phone) and TV learning (television). The new service Virtual C @ mpus Mobile (mobile learning) is also available, and it allows learning through mobile devices (mobile phones, Pocket PC and Smartphone) including education, communication and information. With this service students will be able to enjoy the courses and curriculum directly on their mobile device.

3. THE SURVEY

We believe that, as underlined by Elgort (2005), the adoption of mobile learning in the university context will be influenced by organisational, socio-cultural, and intra- and interpersonal factors, *inter alia*. To determine if our university students were ready for mobile learning, in the spring of 2010 we conducted this survey of student ownership and use of mobile devices and readiness (implicit and explicit) for mobile learning. The survey was done by doing 174 structured interviews with university students, who volunteered to participate in the survey. The structured interview took around 10 minutes. We asked the students about the mobile devices that they were already using (i.e. Which of the following mobile computing/communication devices do you currently own? Which of the following mobile computing/communication devices do you have with you now?), as well as the activities they were engaged in while using these devices (i.e. Which of the following mobile computing/communication activities do you regularly engage in?). We checked if students were integrating, knowingly or unconsciously, mobile technologies into their learning activities (i.e. scale of mobile learning). We asked students about their knowledge of the mobile, if they knew what mobile learning is (i.e. Do you know what mobile learning is?) and if they had mobile learning experiences (i.e. Have you had mobile learning experiences?). We asked students about their specific readiness and conscious will to do mobile learning (i.e. Are you ready for mobile learning? Would you like to do mobile learning?). We investigated our student's implicit will and unconscious readiness to do mobile learning (mobile learning implicit will scale and mobile learning unconscious readiness scale). Finally, we asked students their socio-demographic characteristics, such as gender and age.

The sample

Our sample is composed of 174 Italian university students (of which 86 are males and 88 are women; mean age is 22,41 and SD 2,573). Our subjects do not study engineering or informatics disciplines. Most of the students from our sample (56.3%) use public transportation to reach the university (16.7% on foot, 13.8% by car, 7.5% by scooter and 5.7% by bicycle). Those who use public transportation spend on public transportations: less than fifteen minutes (19.5%), from fifteen to thirty minutes (29.9%), from thirty minutes to an hour (39.7%) from an hour to two hours (7.5%) and more than 2 hours (3.4%).

4. RESULTS

Concerning the other mobile devices owned, Table 1 reveals that the most common mobile technology is the cell phone, followed by laptop computer and ipod/mp3 reader. The ebook reader seems to be the latest used mobile device in the list. The findings in our sample concerning the mobile devices owned by students are in line with the results obtained by Jacobb and Issac (2008) and Corbeil and Valdes-Corbeil (2007).

Table 1. Mobile devices owned by students

Mobile device	Percentage
Cell phone	100
Laptop computer	81
Ipod/mp3 reader	79.9
Portable navigator	25.9
Psp (PlayStation Portable)	10.3
Nintendo DS	9.2
Ipad	4.6
Ebook reader	1.7

All of them owned a cell phone, but most of them (87.4%) do not know what the operating system of their cell phone is. Most of them changes cell phones several times a year (74.2%), 14.9% once a year and only 10.9% less than once a year. We suppose that the majority of students change their cell phone several times a year because it is a stautus symbol in Italy (Petruzzellis, 2010).
All of them have their cell phone always turned on during their free time, 42% always has the mobile phone turned on, 43.1% turns off the mobile phone at night, 21.8% turns off the mobile phone occasionally in order not to be disturbed and only 1.7% turns off his/her mobile phone during working hours and/or during the hours of study.
The students were not expecting to be interviewed so they were not bringing special devices with them for the occasion. Regarding the mobile devices subjects were carrying with them at the moment of the interview (i.e. Which mobile devices do you have with you at this moment?) 97% of the sample was carrying with him the mobile phone, 44,3% the ipod/ mp3 reader, 13.8% laptop computer, 4% a portable navigator, 0,7% PlayStation Portable, 0.6% ipad, 0.6% a Nintendo DS and 0.6% an ebook reader.
For what regards "Mobile Activities" performed by our sample, Table 2 shows that sending and receiving short text message (SMS) and MMS and make calls top of the list.

Table 2. Type of Mobile Activities that students engage in

Type of Mobile Activities engaged in	Percentage
Send and receive short text message (SMS) and MMS	99.4
Make calls	99.4

Alarm clock	90.8
Take photos /make films	64.9
Organize your agenda and contacts	48.3
Listen to radio/mp3	42.5
Surfing the net	29.3
Audio recorder	20.7
Send and receive e-mail	18.4
Use social networks	18.4
Satellitar navigator	14.4
Video calls	2.9

Regarding mobile activities taken part by our sample, in most cases, students do not do several communications activities such as using e-mail and social networks because the costs of internet connections in Italy is quite high, and our subjects do not spend a lot of money to charge their mobile phones (see "How much do you spend on average each month on phone traffic?). Our subjects use the mobile phone in particular for activities that do not need an internet connection. In fact, students of our sampling spend monthly an average of: less than 10 Euros (17.8%), between 25 and 50 Euros (45.4%), between 25 and 50 Euros (29.3%), between 50 and 100 Euros (5.7%) and more than 100 Euros (1.7 %).

We asked students which mobile activities attracted them most. We asked students to evaluate the Attractiveness of several mobile activities on a scale from 1 (not interested at all) to 10 (very interested). We chose this scale because the system of evaluation in the Italian school from elementary to high school is based on a 1-10 scale. If the evaluation is inferior to 6, it is negative, if the evaluation is 6 or more, then 6 the evaluation is positive.
In Table 3 we reported the mobile activities that our students would like to do with their mobile phones (% refers to the evaluations greater or equal to 6).

Table 3. More interesting mobile activities

More interesting mobile activities	Percentage
Surfing the Internet	62.1
Organize your agenda and contacts	59.8
Taking photos	55.2
Receiving and sending e-mails	45.7
Attending lectures/courses	44.8
Making payments (buses, highways, parking, etc.)	42
Making movies	35.6
Watching films/television programs	35.6
Using social networks	35.1
Managing other devices at home	33.3
Receiving news	29.9

Concerning knowledge about mobile learning, 8 % of our samples do not know what mobile learning is, and of the 174 student survey respondents only two (1.2 %) have been involved in an m-learning experience before. The interviewer, after giving a definition of mobile learning to those who did not know what mobile learning is, asked subjects "would like to do mobile learning?". 44.8% responded yes, and 55.2% responded no.

But in fact if we ask them which of the following mobile learning activities they would like to do, their desire to do mobile learning results evident!
We asked students to indicate a value from 1 to 10 about how useful (from 1 – useless to 10 - very useful) they would regard some services connected to learning on their mobile phones (% refers to the evaluations major or equal to 6) (Table 4).

Table 4. Mobile activivities connected to learning

Mobile activities connected to learning	Percentage
Having questionnaires to check their preparation	75.3
Having summaries of all the lessons	71.8
Having a virtual space to exchange diagrams, summaries and comments with other students	71.3
Having real-time access to classes from outside the university	65.5
Having Miniguides, made by other students, about how to prepare for their exams	60.9
Having a map that shows you classrooms, places and services around you	60.1
A chat system to find those around you who are studying your topics	50.6

We asked subjects if they had done e-learning before this interview, 62 subjects answered yes and 112 subjects answered no. We asked these subjects their opinion about the utility of e-learning:

- of the 62 subjects who had done e-learning, 59 answered e-learning is useful and 3 answered e-learning is useless.
- of the 112 subjects who had never done e-learning 68 answered that e-learning is useful, and 44 answered that e-learning is useless.

5. CONCLUSIONS

Starting from the point that people who have tried e-learning have an opinion significantly different from people who have never done e-learning, we suppose that people are somehow diffident about a new learning methodology, and they can change their opinion after have tried it, and maybe they can also realise that really they are already unconsciously doing some activities which are part of the new learning methodology.
Before introducing mobile learning, we believe that it is necessary to understand which mobile learning activities people are already doing, and starting from these activities, invite them to try other ways in which their mobile information technology can support them in the learning process.

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Mobile Phones: Dialing for Success in Spoken Learning and Assessment

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Abstract

This proposal seeks to explore the role that handheld mobile devices can play in the learning and assessment of spoken language. Teaching foreign languages can be challenging, it can be difficult to keep students engaged and motivated. Assessment of spoken language can be difficult to achieve in an effective and reliable manner. This study will focus on two large projects in the field that used handheld devices in the teaching and assessment of spoken language. The study when presented will be supported by a practical demonstration of the technology employed during these projects.

Keywords

Mobile phones, spoken assessment, language learning.

1. INTRODUCTION

Often young people view foreign languages as uninteresting and too abstract which affects their motivation levels negatively. Male students can sometimes disengage from language learning as they can view foreign languages as a more female dominated area (European Commission Multilingualism). Teachers need to find ways of adapting current techniques to increase relevance, motivation and that are adapted to suit the needs and expectations of young people.

Assessment of spoken language has traditionally been more challenging to assess in an independent and standardised way (McNamara 1996; Norris et al 1998; Skehan 1998; Wiggins 1998; Norris 2000).

This session will explore two large scale projects that employed mobile devices to study affects on student competence, motivation and their potential for use in assessment

2. AREAS OF STUDY

The Irish language (Gaeilge) is taught in schools throughout the island of Ireland. Despite many years of study throughout primary and secondary education, many young people leave school without an affection for or competent grasp of the language.

To address the issue, the then Irish Minister for Education, Mary Hanafin, announced that from 2010 the oral component would make up 40% of the Irish language state examinations. These state exams in Ireland are the *Junior Certificate* which is delivered to those in the age range 14 to 15 years and the *Leaving Certificate* which is the final exam at second level for students typically ranging from 16 to 18 years.

The assessment of these spoken exams poses a sizeable logistical challenge to schools. The exams are face to face in the style of an interview. The examiner is usually a teacher from another school who has been taken away from his/her own students at exam time, a period of critical importance. Teachers unions do not support this practice.

In response to this issue, the Minister initiated a project known as FÓN to investigate the use of Information and Communication Technology (ICT) in the teaching, learning and assessment of Irish.

The technology provider chosen was Learnosity who's leading learning and assessment solutions is mobile phone based.

The second study focuses on third level language learning. The Open University (OU) is the United Kingdom's only university dedicated to distance learning. The University currently has around 150,000 undergraduates and 30,000 postgraduates. Most Open University courses are available throughout Europe and some of them are available in many other parts of the world. More than 25,000 Open University students live outside the UK.
Increasingly more of the OUs students are using course material whilst on the move and this has led a rethink in terms of improved teaching and learning provision leading to collaboration with Learnosity.

3. TECHNOLOGY

The projects in question used several components of the Learnosity Voice suite of products. The products are designed to use already familiar interfaces. Various studies have shown that the use of familiar technologies can have a positive impact in an educational setting (Jones, et al, 1995; Collett, et al, 1999). Mobile phones are widespread in Ireland with penetration in the market at 108% excluding mobile broadband. (Comreg: Quarterly Report for the period October-December 2009 – Q4 2009). The proportion of adults in the UK who personally own/use a mobile phone is 89% (Ofcom, Q1 2009).
Participants in the projects merely required access to a mobile phone and a PC or laptop.
The mobile phones required were basic models requiring GSM 2G talk and text support. The Learnosity components used were:
Voice Chat – Enabling one to one conversations (on mobile phones) between the students on a particular topic

set by the teacher. All conversation is recorded on the system so both the teacher and student can listen to it afterwards. This element was used by the FÓN study only.

Text Chat (Beta) – Web based text chat sessions between students. A transcript of the conversation is stored for review afterwards. This element was used by the FÓN study only.

Voice Response– Enabling spoken homework and self assessment, the student connects to the system and responds to voice prompts that have been set by the teacher. Used by both FÓN and The Open University.

SMS Vocabulary – word per day delivered to the student's mobile phone using text messaging/SMS. This element was used by the FÓN study only.

Both teachers and students were given access to secure online areas where they could manage certain aspects during the project. The teachers could use the area to access the student work that had been recorded, and in the case of FÓN initiate Chat and Text Chat session for the class(es) and schedule delivery of the SMS.

Students similarly had an online area that they used to play or download their own recordings and see any teacher feedback associated with them, listen to sample answers for each prompt on the system, access text connect sessions and track all SMS received where applicable. Below is a system overview of the Learnosity Voice platform. The platform is a centralised managed service that does not require any installation of servers by the school or institution. This offers advantages to schools in terms of financial and operational effectiveness.

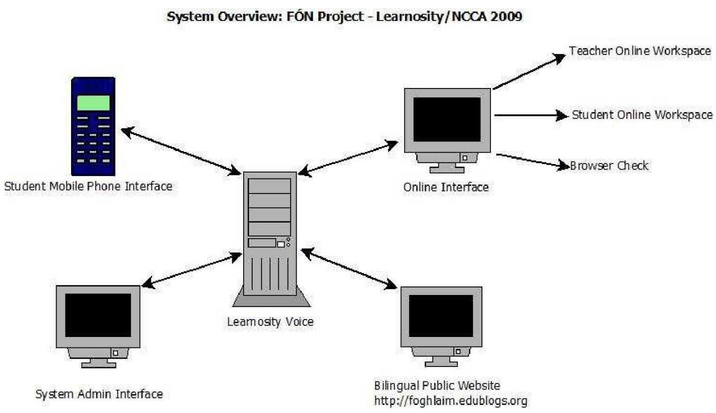

Figure 1: System Overview Learnosity Voice

4. LEARNING MATERIALS

In the FÓN projects the learning material and exercises were closely aligned to the Junior Certificate oral exam structure.

The subject matter available on FÓN was:

1. Mé féin (About me)
2. Mo chlann (My family)
3. An teach (The house)
4. Mo scoil (My school)
5. Áit chónaithe (My neighbourhood)
6. Caithimh aimsire agus spórt. (Hobbies and sport)
7. Poist agus slite bheatha. (Jobs and Careers)
8. Laethanta saoire agus taisteal. (Holidays and travel)
9. Na séasúir, an aimsir agus féile na bliana. (Seasons, weather and annual holidays)
10. An corp, sláinte agus tinneas. (The body, health and sickness)

(FÓN 2009 Report, NCCA)

The third phase of the project, FÓN 3, was very much assessment focused and a dual approach of gathering evidence of learning and tailoring the system to closer replicate the state exam was under taken.

Students built up an e-portfolio of work from which they selected what they considered to be their best work and put this forward.

A mapping exercise took place and the following was the output (NCCA, FÓN 3 Report, not yet published).

Table 1: Learning Material

Oral Examination Component	Format of FÓN	Student Selected Evidence
Greetings/ Welcome	Addition of further questions to the existing Mé Féin section. Teachers could add in content if they wished.	Students selected their 3 best for assessment.
Role Play (x8)	The themes of the 8 role play & 5 picture sequences match the topics in FÓN. Additionally, 8 new chat stimulous were put in place and students randomly assigned roles to emulate the examination role play.	Students asked to do at least 6 roleplays and select their best 2 for assessment.
Picture Sequence (x5)	A new element was added to FÓN to emulate the picture sequence part of the examination. The student was randomly assigned to any 1 of 5 picture sequences and was asked related questions.	Students asked to access the section at least 6 times and select their best 2 for assessment.
Interview	A. Students used the question and answer topics to practice. B. Students chat to one another on topics prescibed by the teacher. C. Students access and respond to teacher tailored questions.	A. Students identify and submit their best 2 question and answer sessions for assesment. B. Students identify and submit their 1 best conversation for assessment.

The FÓN system by the commencement of FÓN 3 was configured as follows:

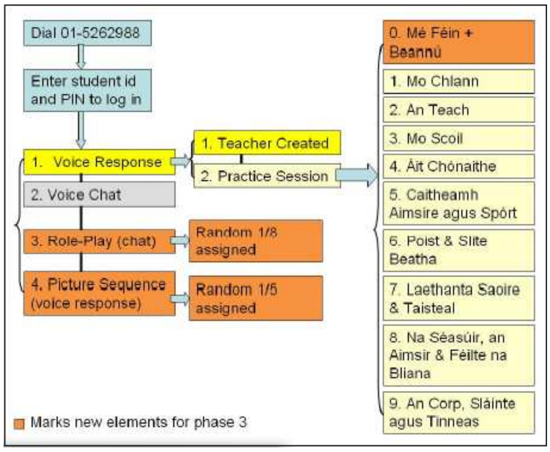

Figure 2: FÓN System Phone Interface

5. PROJECT OBJECTIVES

5.1 Open University Project Objectives

The objectives of the study were simple and straightforward:

- Gain an understanding of the different contexts in which students would engage in mobile activities.
- Measure how frequently students will work when on the move and how long they would spend doing this.
- Explore what aspects and what type of activities they find most beneficial and why.
- Evaluate the benefits of providing students with mobile listening and speaking activities.
- Better understand how interactive activities would integrate with mobile technologies.
- Ascertain if the university should integrate mobile speaking in the design of new courses.

5.2 FÓN Objectives

The Irish project has thus far spanned 3 phases. The first phase, the MALL project took place in 2007, and was concerned with the evaluation of mobile phones as a tool for learning and assessment.
The second phase, known as FÓN, expanded the scale of the project, again to evaluate the potential gains in using mobile phones for learning and assessment of the Irish language.
The initiative then focused on the use of mobile phones for use in formal spoken assessment for the third phase.

6. RESEARCH METHODOLOGY

6.1 The Open University

Students from the Intermediate French course were chosen to participate and content from the existing French DVD-ROM was adapted for use on the mobile phone. Typically, a course such as this represents 30 hours of learning with about 21 hours of tutor support that can range from face to face tutorials to personalised feedback on assignments.

The project used Voice Response which prompted students for voice responses to specific questions in French. The responses were recorded and made available to the student to replay and compare with a model answer.
In some cases, structured conversations were devised where students could hear their response interleaved with the pre-recorded samples.
A small sample group (35 students) was recruited from the French Intermediate level group. Members of the group used the system and completed questionnaires weekly that provided qualitative feedback.
The activities included in the project were varied and included, grammar drill, dialog, oral presentation, pronunciation-intonation and listening. A total of 34 examples were provided for students to work through optionally. A lower cost phone number was used for accessing the system and the students could attempt questions and re-record multiple times if desired. Each student had access to an online area where they could see and play the responses using a media player.

6.2 FÓN

For the second phase of the project spanning 2008/2009, a total of six schools were involved. These schools were split 50/50 Republic of Ireland and Northern Ireland. All of the schools bar one had good ICT facilities with 3 to 4 computer labs on site. The remaining school had fair ICT facilities with 1 to 2 computer labs in the school. Some 14 teachers and 420 students participated in the project. The gender profiles were 2 all female schools, 3 mixed and 1 all male.
The students were divided into 2 groups within each school. Group 1 participated in the project during the first applicable school term whilst during this time Group 2 remained a non-participant control group. For the second term of the project the groups alternated roles
Data was collected in a number of ways, questionnaires, interviews, teacher daily diaries, audio recorded by Learnosity, observation and school visits. The evaluation methodology was externally validated by Dr. Françoise Blin of Dublin City University.
The evaluation in terms of assessment focused on addressing the following questions:

- How effective are the technologies for teachers' assessment of students formatively and summatively and for students in self-assessment?
- Could this model be used in external assessment such as the Junior Certificate or GCSE examinations? Do the technologies offer possibilities for oral assessment? Does the current project represent a scalable model?

- Could the same model be implemented country wide? Is this feasible when we examine administration of candidates, types of exams and scaling the technology?
- Do the technologies offer any value over more traditional methods of teaching, learning and assessment?

(NCCA FÓN Report 2009)

The third phase of FÓN focused on two schools. School One had participated in the previous phase of the study and from this school four Junior Certificate classes were chosen. The second school had no previous experience with FÓN and one Junior Certificate class participated. In total there were 117 students and their 5 teachers participating in the project. Data was gathered in a number of ways both pre project from school one and post project from both teachers and students in both written and oral formats. System usage was examined as well as overall student achievement during the period. Case studies of 3 students per class were put together.

6.3 Practical Considerations & Challenges

The mobile phones were provided by a mobile phone operator in Ireland. The company provided a discounted per minute call rate of €0.02. This rate was applied to cross border roaming also so was applied to the schools in Northern Ireland also. The charges to date have been borne by the NCCA, an arrangement that is not feasible on a larger scale. In the yet to be published report from FÓN 3, the recommendation is that FÓN is free for students in future.

The phones were configured at network level to block outgoing SMS, could only dial out to the FÓN number and could not accept incoming calls. Initially the blocking was not in place in a consistent manner leading to some phones not accepting incoming messages. These issues were resolved by the end of the project.

Breakages of the phones did not arise as a major problem throughout the project. The NCCA report on FÓN 2 reports that students felt privileged to have the phone to use so looked after it well. Some teachers stated that any damage caused was from overuse rather than misuse. Others though felt that the phones were not as well minded as the students own phones. The majority of schools gave the phones to students for the duration of the project, only one school handed out the phones at class time only. Just one school reported a case of disciplinary action taken in relation to misuse of the phone where the devices was used to cause disruption in other classes.

In terms experiences with PCs, headsets were bought by some schools for the students to use in language labs in order to listen to their work. One school was provided with two laptops and headsets for teachers use as there was a lack of access to computers in that case. The teacher's computers needed particular plug-ins to be installed in order to support the authoring of questions. The system performed a browser check when the teacher logged on for the first time and the plug-ins were loaded if they were missing from the machine. The web addresses associated with the project were white listed on the web filters that are in place in the schools.

In terms of training, teachers had several training days and phone training on a regular basis. Feedback in the FÓN 3 report, yet to be published, suggest that greater networking and communication amongst teachers would be beneficial

7. PROJECT RESULTS

7.1 The Open University

In terms of usage the most favoured location by the group was at home.

The participants highlighted 3 areas that they found most useful:

- Using mobile phones enabled additional practice and grammar.
- They enjoyed the challenge and the authentic, real aspect of the experience.
- They saw the potential to complement the DVD-ROM or other course material.

The group told researchers that they enjoyed the challenge of this new type of activity, as well as the authenticity of the experience as a way to learn language. They also reported that the exercises were easy to do on the move.

Since the initial study the exercises have been extended to include all students on the Intermediate French course to use as a revision tool

What the Students Said:

- "I really enjoy listening and then also having to listen to the question which seems a more authentic way of doing listening comprehension. So really useful and very challenging."
- "I think to repeat actual words and sounds is a very good exercise to do on the phone. It's easy and lends itself very much to do on a phone or mobile etc"
- "This is a good experiment actually to see how much I can understand with one listening."
- "It was challenging and interesting."
- "Answering them orally rather than writing them is also a new experience. Very demanding but really useful practice."

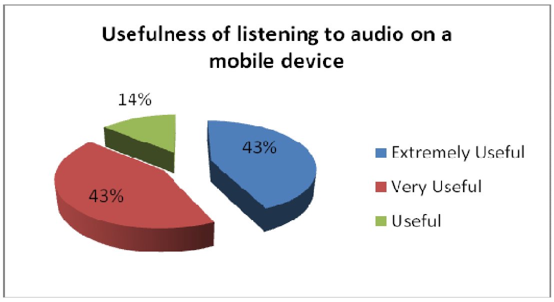

Figure 3: Usefulness of audio on a mobile device

The project has been extended to a second phase which encompasses both English and French. The content has been skillfully authored with focused exercises designed to work on building certain skills such as pronunciation, verbs etc.

7.2 FÓN Phase 2

Teachers reported that students had no problems at all learning how to use the FÓN system. Within a short period of time they had memorised passwords and PINs as well as the IVR navigation tree allowing them to skip ahead by interrupting prompts.

One teacher in the NCCA FÓN report described how the student's use of mobile phones for social and personal means impacted positively on their use for learning Irish. The enjoyment levels did not decrease as the study progressed.

Teachers reported an improved perception of competency when comparing pre and post the project. The reported change was from 27% very good at speaking and 36% good before the FON project to 75% very good and 25% good after the project.

Listening skills were also perceived by the teachers to have improved, changing from 9% very good, 18% good and 64% ok to 50% very good and 50% good. Reading and writing skills were also reported to have improved (Keogh, Ní Mhurchú, 2010).

Student views concurred with the teachers in that they reported increase competence in oral Irish. Specifically students said that they had a greater vocabulary, were able to think of the right word to use faster and being able to recognise words that they had heard on the phone when they heard them in another context.

The system usage suggests high levels of engagement by the students:

- Students listened to and spoke Irish for a phenomenal 882 hours.
- 15,374 calls were made by students to the Learnosity Voice system.
- On average Learnosity recorded 42 calls per student or 2.5 hours of Irish talk time during the 11 week period per student.
- Phone calls were made by students as late as 11pm and 6 am to Learnosity Voice.
- The highest user of Learnosity Voice made 272 calls on the project, totaling 4 calls per day, including usage on the weekend.
- Students continued to use Learnosity Voice after the project had finished, all at their own cost.

(info@,NCCA, Feb 2010)

"Students phoned the system after school and early in the morning. They even used their own phones after the project ended. This was a telling sign that the project genuinely engaged them." Teacher participating in the FÓN project, cited in the NCCA, FÓN Report, 2009.

Students reported improved speaking abilities, with 73% of the participants saying that their Irish had improved more than normal as a result of being in the FÓN project. One student said, "I feel I have improved because I had the chance to speak and hear Irish more than what I usually would." Another summed up the experience with "...I realised it's not that hard to talk in Irish." (NCCA, FÓN Report, 2009)

In terms of comprehension of Irish, a further 19% reported that this skill had improved and one explained that this improvement meant that he knew "what most of the questions meant without checking it." (NCCA, FÓN Report, 2009).

The student feedback echoed that of the teachers with the main positive areas being, they were more motivated, they felt more confident, under less pressure, could hear their mistakes, construct sentences and overall Irish became easier (NCCA, FÓN Report, 2009).

Students recognised that learning and practising language this way made Irish more interesting, fun and enjoyable and allowed them to learn Irish quicker. They liked that it was a different way to learn Irish and told of how the system helped them understand dialects (NCCA, FÓN Report, 2009).

"I did enjoy using phones as it made Irish interesting and fun!! For once I didn't mind doing Irish homework." (Student, FÓN Project Report, NCCA, 2009).

"I liked the whole ideas of using the mobile phone as it is something that young people can relate to and enjoy. Also it is easy to use. I did not dislike anything at all about the project." (Student, FÓN Project Report, NCCA, 2009).

7.3 FÓN Phase 3

This phase saw further evidence of the use of mobile phones to promote autonomous learning. Apart from the 9% of students who used FÓN at school the rest of the usage could be attributed to outside school learning (NCCA, FÓN Report Phase 3, not yet published).

Mobile phones proved a popular method for preparation for spoken exams with 86% of students indicating that they found the method useful. There was support for using FÓN as a way to earn marks for the Junior Certificate, 93% of students claimed it would be a way to have fun while you work, its supports the importance of spoken language and it would be better than the traditional method (NCCA, FÓN Report (Phase 3), not yet published).

Teachers agreed that using FÓN was a lower pressure way of assessing language, one said, "they nearly lost their lives around the oral exam but listen to them on the FÓN system and they're nearly singing" (NCCA, FÓN Report (Phase 3), not yet published).

The detailed case studies in the not yet published report from the 3rd phase of the project give us some interesting evidence. Below is a selection:

- Student 1, female, high user of FÓN and a good student. She went onto sit the interview style Junior Certificate oral exam but did not achieve to her potential due to nerves. If this student was judged on the basis of continuous assessment through FÓN, the result may have been quite different.
- Student 2, female, quiet, lacking confident with health problems. This student used the FÓN system on periods of absence from school and achieved a higher than expected grade in her Junior Certificate oral exam that her teacher attributed to her use of FÓN.
- Student 3, female, never speaks in class with generally quite low grades. This student accessed the system 450 times and the teacher reported that the only time she was heard to speak was on FÓN. This student went on to achieve a better grade in the state oral exam than her teacher had envisaged that she would.
- Student 4, male, not motivated to learn Irish, disruptive in class and homework rarely done well if at all. This student's teacher noted that FÓN was the only time that she had heard this student speak and that his oral competency had improved markedly over the course of the project.

7.4 CONCLUSIONS AND RECOMMENDATIONS

"The findings and discussion around this innovative use of audio e-Assessment have been well received at a number of internal and external sessions [at the Open University]." Rhodri Thomas, Mobile roundup – audio, eBooks, apps and coordination.

Key positive student feedback centered on the authentic experience of working with audio prompts and spoken responses, the ability to effectively construct a dialogue between pre-recorded audio interweaved between student responses in playback and the potential to compare with exemplar answers.

Output from the group has led to Learnosity adding two more elements to the solution, Skype access and an iPod touch/iPhone application.

Learnosity continues to work closely with the Open University to support them in their deployment of mobile e-learning and e-assessment.

Work is now underway to move to a full pilot program. As well as formative assessment the pilot will include summative assessment enabling tutor feedback on line. The Open University is also investigating and evaluating possibilities in other discipline areas.

Findings from all of the NCCA studies as part of this initiative have shown that using mobile phones to as a tool for learning and assessment improves student competency, motivation and confidence. FÓN has also been shown to be an effective tool for self assessment and teacher assessment.

The yet to be published report on the latest phase of the study will recommend that the next phase will include in excess of 50 schools and spread across the three years of the Junior Certificate cycle, first year through to third year at secondary level, years 8 - 10.

Learnosity solutions have leveraged the communication tools already familiar to students to deliver an initiative and beneficial and cost effective method of spoken language learning and assessment.

8. ACKNOWLEDGMENTS

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Appropriation of an online mobile community by marginalised young people - experiences from an Austrian case study

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Abstract
According to the notion of appropriation users find new ways of using a specific piece of technology depending on their preferences and needs. This applies also to a mobile learning community for marginalised young people who used a mobile community platform not only for intended aims but for further purposes. In the framework of the EU-funded project ComeIn a specific platform has been developed and tested in a pilot phase running in the United Kingdom and Austria for three months. Results herein are based on the Austrian pilot. The multi-methodological approach comprises quantitative and qualitative measures such as log data or interviews. Key findings that show the appropriation of the platform are presented in this paper.

Keywords
Marginalised young people, online mobile community, appropriation.

1.INTRODUCTION
The concept of appropriation according to Bakardjieva (2005) states that "with creative appropriation, new dimensions of a technology are opened up and widely recognized, thanks to the spontaneous inventiveness of its users" (p. 18). Thus, the creativity of individuals has led to a multifunctional use of (mobile) devices (c.f. Pachler, Cook et al. 2010; Pachler, Bachmair et al. 2010). Vavoula (2007) in this context recommends that a productive pedagogical vision should explicitly recognises the cultural emergence of innovative educational practice following Bakardjieva's concept of appropriation or "technology-in-use-in-social situations", or in "learner-generated context" as coined by other researchers.
How this concept applies to the pilot study carried out in the framework of the EU-funded project ComeIn, specifically how the users have integrated and adapted the developed platform to their preferences, is the main focus of this paper.

2. THE PROJECT COMEIN
The project ComeIn – Online Mobile Communities to Facilitate the Social Inclusion of Young Marginalised People (funded by the European Commission under the Seventh Framework Programme, http://www.comein-project.eu/) - investigates and examines possibilities of mobile online communities as learning instruments which could foster social inclusion. It studies and utilises mobile networks as a means for social inclusion. This approach combines the benefits of the online community concept with an inclusive approach, realised through the most abundant device used by marginalised youth in Europe – mobile phones.
ComeIn is a two year lasting research project ending at the end of October 2010. A multidisciplinary consortium has worked to study the user needs and then to develop an online mobile learning platform that meets the gathered requirements.
For the ComeIn study the consortium adopted the following definition for marginalised youth: Marginalised young people are defined as "group of young people with fewer opportunities in different arenas." In our study we focused on young marginalised people mainly affected by two broad but specific categories: education and economy. Young people between the age of 14 and 21 who are neither engaged in education nor job are the target group of ComeIn. These are mostly young people who have dropped out of school after completing compulsory school age before formal graduation and have not been successful in entering the employment market so far.

2.1 The Platform
Based on literature review, expert interviews and focus group discussions with people who match the criteria of the target group several recommendations for the technological development of the online mobile community platform could be gathered. Since reading and writing seem to constitute challenges for the target group one of the resulting recommendations led to a rather visual design of

the user interface as well as to "visual" content creation instead of relying heavily on textual information (c.f. Figure 1). Thus, the ComeIn consortium decided to use video streaming as central means of communication and learning on the mobile learning platform. Registered users can upload videos they have shot on their mobile phone via the build-in camera to the platform and can access their own and others' videos.

Figure 1 : User Interface

To make use of the video streaming feature ComeIn elaborated a video-ping-pong approach. During the pilot period 'challenge videos' were posted by the facilitators on the platform. These pre-prepared challenges followed a twelve step structure, each step after one week which all referred to entrepreneurial skills, from topics such as "self-motivation" to "exploring different job opportunities". The facilitators created different versions and tasks of each challenge to leave it up to the participants to which one they would decide to answer. Participants were also free to answer to all suggested tasks and they could also decide upon either creating an answer video by their own or in collaboration with others. Furthermore, also participants could create their own challenge videos, create groups to discuss topics of interest, rate others' videos and send messages to other participants or post them on the group walls.

2.2 The Pilot

In total, 98 participants took part in the ComeIn pilot for three months, half of them were from the United Kingdom and the other half accessed the platform from different regions in Austria. During the pilot eight facilitators were responsible for uploading the challenge videos, providing feedback, setting interventions such as calls or text messages in case help was needed or motivation among the participants to take part was decreasing and also safeguarding netiquette issues.

Participating young people were asked to regularly visit the platform and to take part in different community activities including three face-to-face meetings. In an introductory session the platform was explained in an interactive way as well as netiquette rules were discussed among the groups. The intermediate meeting served to collect preliminary feedback on the platform and within the debriefing meeting at the end of the pilot all participants received the mobile phone they already had used during the pilot and a certificate for successful participation as incentives.

The followings results are based on Austrian results since we got to know the Austrian participants and were able to arrange interviews with them and focus group discussion.

The Austrian participants acknowledged rather low levels of literacy and numeracy, but were interested in Information and Communication Technologies. All of them had an own mobile phone and almost half of them had a personal computer or a laptop in their household which was not in all cases with an Internet access and only rarely with Broadband Internet. Only a few of them had already actively participated in a social network sites.

3. EVALUATION METHODOLOGY

For evaluation purposes different methods were combined to cover the different aspects of the online mobile learning platform. An automatic log data collection tool stored data such as the first and the last log-in in a specific period of time per participant as well as the number of uploaded videos, the number of sent messages to other participants and the ones sent to groups, the number of ratings, etc.

Video questions were used to ask participants whether they were satisfied with the usability of the platform in respect to different features. Focus groups and interviews were arranged to get more in depth-information on the user experience and to understand what the ones with low participation rate did not like on the platform or which other reasons hindered them from participating. Facilitators of the platform were also interviewed.

To gain more insights into learning aspects data gathered in interviews and focus group could be contrasted against the actual artefacts, i.e. the videos young people had uploaded in the course of the pilot.

Finally, a social network analysis identified different roles of participants.

4. RESULTS

In the following the most important findings of our study that show how the participants have used the platform besides the intended aims will be described. Obviously within the constraints of this paper we will only be able to touch major topics.

As retrieved from the log data the most used features were uploading and accessing videos besides sending messages and creating groups. In total, all participants together in the three months of the pilot have uploaded 550 videos and accessed 3,759 video clips. Furthermore, they have exchanged 1,983 messages and sent 722 additional messages to 66 groups in sum. Other features of the platform in comparison to these numbers have only been rarely used, such as the option to rate videos and to upload answer videos.

In times of technical problems when accessing videos was not possible for some participants they switched to sending messages and creating groups to discuss topics of their interest. Thus, some found strategies to deal with constraints of the platform while others in such periods turned away from the platform as we would have expected.

While the overall use of the platform was high in terms of online time and number of uploaded videos or exchanged text messages the variance of use was considerable. Different user types could be identified within the log data. Among the 48 Austrian young people two were heavy users with more online time than the total accumulated online time of the rest of the sample. Both used the platform like a log diary sharing their ideas and activities of their daily life with others. In contrast to these very active users rather passive users did make more use of accessing others' videos instead of creating their own. These participants stated in the interviews that they did not want to expose themselves to others or feared that they would be judged by others or did not have ideas what videos to shoot.

According to Nielsen's (2006)observation in online community the participation rate of lurkers, who read or observe but do not contribute, is 90%, and the share of intermittent users who occasionally contribute is 9% and only 1% can be called heavy contributors. This 90-9-1 ratio is slightly different in the ComeIn platform: The shares are 54 % who can be considered as lurkers, 30% occasional platform users and 16% as actives users. Thus, the overall rate of active users is higher on the ComeIn platform compared to other social network sites.

However, not only the participation rate differed but also the roles the participants appropriated during the pilot differed as can be seen in figure 2. The displayed network resulting from a social network analysis (Scott 2000) is based on the messages exchanged between all participants who are represented by a yellow dot and by an identification number. The bigger the yellow circle, the more messages the young people have sent. The black lines connect sender and receiver of a message, the thicker this line, the more messages have been exchanged between these two persons.

While some members of the community play a central role as they sent and received many messages and are connected to many other community members, some have only a few links to other people and some seem completely isolated in terms of sent and received messages.

The use of messages was a strong driver for the community and interestingly despite language barriers, messages were also exchanged between the Austrian and the British participants. In the interviews the participants revealed that the sent messages were used to inform others what they were up to or to ask how the others were feeling.

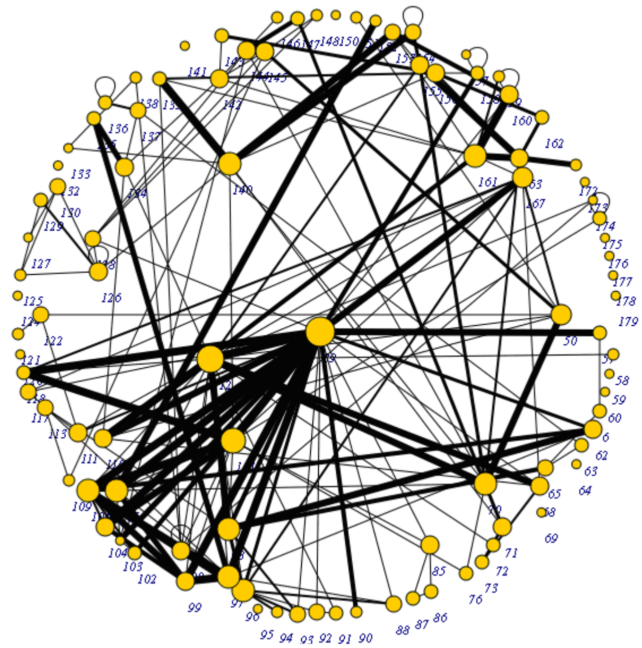

Figure 2 : Network of sent messages between participants (Metodi 2010)

Participants did not make much use of the platform for the intended purpose which was to react to the challenge videos or to make use of the ping-pong-system, create own challenges or reply to others' videos by uploading an answer video. This might be due to technical reasons since the usability regarding the uploading of such answer videos in the interviews turned out to be somewhat limited.

However, interestingly the participants used the platform mostly for other aims besides the ping-pony-system. Thus, they did appropriate the technology to their needs. The artefact analysis of the uploaded videos shows that some used the platform, as previously mentioned, like a diary, to share their daily activities and experiences. The wish to express themselves was obviously one of the most important purposes to use the platform and in doing so, the approaches have been very creative. One of the participants, for instance, lent his voice to a computer game hero to express what he was thinking instead of directly speaking into to the camera. Others filmed their surrounding, such as their room, the street they were living in or their pets. One used the platform to create an alter ego.

Some just recorded videos on youtube or filmed shows on television. The entertainment aspect seemed also very important as some video clips show things and objects or scenes they found funny. In a few cases a development of personal disclosure in the course of the pilot can be observed: the first videos uploaded by them are very "neutral" and "impersonal", later on they involve family members and other friends, thus they become more explicit on some personal matters which have been hidden at the beginning.

At the beginning of the pilot more videos with experimental character, i.e. the participants obviously playing around and testing the platform, are to be found while towards the end of the pilot more meaningful videos can be identified where it becomes obvious that participants have reflected and probably developed an idea or a short "screenplay" before shooting and uploading the video.

In the interviews and the focus groups almost all participants emphasised how much they enjoyed the video format. The video especially seems to be an appropriate and additional channel for expressing themselves for some young people who otherwise have difficulties expressing themselves like shy young people, or young people with autism. Two of our 48 participants were diagnosed with Asperger syndrome. Among the Viennese group was also an illiterate participant who made excessive use of the platform.

The facilitators of the platform who knew the participants as they were social workers who were regularly in touch with the youngsters were surprised by the engagement of some of the participants. Some of these turned out to be much more active on the platform than in real life, or some who in real life had problems collaborating with others were heavy communicators on the platform. According to the facilitators changes in behaviour of some participants could be noted, "they blossomed out during the project's lifetime" since they experienced something positive where they could show their strengths and were not under risk to fail. In the interviews some young people said that they felt proud because they had succeeded in managing what they had been asked for. One participant insisted to be able to stay in the platform group until the very end of the pilot although his relation to the social worker had already found an end in the meantime.

However, it is obviously difficult to tell if these changes have partly resulted from their participation in the project or if these changes are due to other factors.

When asked whether they had learnt something in the project most participants stated they had not. Since for most marginalised young people learning has no positive connotations the term learning was avoided throughout the project, challenges were called "episodes of a series" instead for instance. Thus, it is not surprising that when explicitly asked for learning outcomes they could not name any. This result is in line with Vavoula (2004; cited after Clough et al. 2009) who states that one of the difficulties in researching informal learning is that people might be unaware that any learning has taken place at all. The artefact analysis of the videos uploaded by the participants however reveals some of the learning that has happened during the pilot. From an intentional use of the video and handling of the platform but also in terms of content creation results show increasingly self-reflection processes in the course of the pilot among some participants. Some of the marginalised young people involved seem to have improved their skills in video recording, in talking in front of a camera, in expressing themselves more properly and clearly.

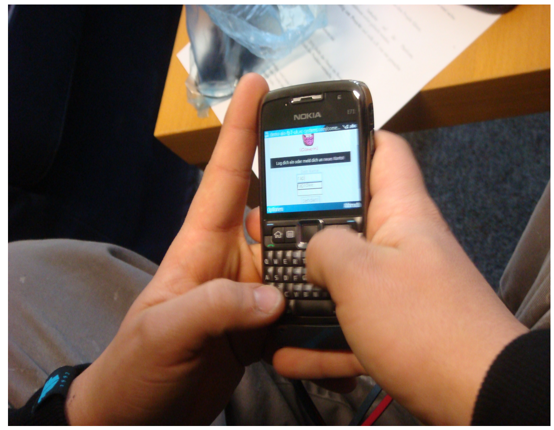

Figure 3 : Young participant logging into the ComeIn platform

There have been only 2 videos out of 550 which had to be removed from the platform because they were in conflict with the netiquette. In both cases the facilitator contacted the participant and discussed again the rules that had to be respected in the community. Most were aware of netiquette and strongly selected the shared information which mainly concerned themselves (the videos which have been uploaded are sort of "the selected ones" and we can predictably assume that others have been recorded and not necessarily put on the net).

Appropriation of the online mobile platform among the participants happened in many ways. The mobile is an handy tool, used in different moments of young people's lives (the camera is always available and ready to shoot); on this level, the mobile seems integrated in youngsters' daily life. They used the option to create groups more for statements than to actually exchange ideas. Appropriation happened also in terms of personalisation of the device and the profile page. Instead of uploading their own picture to the profile page some used this option for other purposes, such as to indicate their nationality by uploading their country flag. In respect to the profile page they would have wished for more ways to personalise it as they revealed in the interviews and focus group discussions.

During the pilot the rate of inactive users increased significantly. In the focus group with only young people with low participation rates these admitted that they did not find the time to log into the platform. In these cases users did not find an option to integrate the platform and the mobile online community into their lives and thus, appropriation did not occur.

Not only the participating young people did appropriate the device and the online mobile community platform but also the facilitators used the platform for additional purposes than originally intended. Besides the use of the platform for learning aims the major advantage of the online mobile community was to get in touch with the young participants. During the three months of the pilot some of the young people disappeared completely, they did not visit the social worker and in many cases the contact via the ComeIn platform was the only way to get in touch with them. Also it enabled them to stay in touch with those peers who had left the organisation because they had managed to get a job or because of other reasons. Thus the facilitators appreciated the platform as additional way and channel of communication with young people who were currently visiting the youth organisation but also for follow-up care.

Since facilitators accessed the videos produced by the young people they received some insights into their lives and used some of the new posted videos often as an icebreaker in a face-to-face conversation. Accessing the videos enabled the facilitators to follow the young people to some extent which they found very positive. Also from the young participants' side to know that also adults were having a look on their activities was never mentioned as negative aspect of the community. In the contrary, to know to be part of a trustful environment was repeatedly positively remarked in the discussions.

4.1 Case Studies

To get an insight into the variety of the individual use of the platform three case studies are represented here briefly.

4.1.1 Miko, 16 years old

Miko was born and raised in Vienna. Although he completed compulsory school he is functional illiterate. Miko is member of the Roma community and his arranged marriage took place a month after the end of the pilot. In the youth organisation Miko was known as not very engaged young person who barely showed any interests in anything.

On the platform Miko was the one who uploaded the most videos of all. Since he is illiterate he could not name his videos and not communicate with others via sending and receiving messages. The videos uploaded show his daily life, such as his room, him playing a special instrument, or events happening in his life, such as a wedding.

The facilitators were very surprised by the shown activity on the platform.

4.1.2 Argan, 17 years old

Argan was diagnosed with an oppositional personality disorder. After completing compulsory school age he dropped out of school 2.5 years ago and did not work or continue education since then.

At the beginning of the pilot he was not willing to take part although he had made his parents sign the consent form. After he was assured that he would not have to upload any videos he seemed relieved since as the facilitators suggested he was afraid to fail in some way and to get negative feedback by others.

In the online mobile community he acquired a “safeguarding” role, he informed the facilitator, for instance, of a video clip that might conflict with netiquette rules before the facilitator had noted and he gave feedback to many videos in terms of ratings. Towards the end of the pilot he even uploaded a video.

To be part of the online mobile community obviously was very important to him since when he was forced to leave the youth organisation because of conflicts the first thing he wanted to know is if he could still take part of the mobile online community.

4.1.3 Mia, 17 years old

Mia completed lower secondary school a year ago and has since then been inactive in terms of employment or education activities.

On the platform she has uploaded many videos which express her ideas. She has also accessed many videos uploaded by others but did not rate any. Mia holds the record for the most sent and received messages on the platform. The social network analysis reveals that she has been one of the key players on the platform as she has acted as connecting link between many other participants of the pilot.

5. CONCLUSIONS AND OUTLOOK

The results based on different evaluation methods combining quantitative and qualitative research show that besides the indented outcomes of the project there are many interesting side effects that can be noted. The community aspects seem more important on the platform than learning aspects for the participants. Thus, the platform might very well have contributed to the social inclusion of the marginalised young people involved.

The results show evidence that the participants benefited from the platform as they were willing to integrate it into their daily life. However, a long term study would be needed to verify impacts on a longer scale. Initial signs could very well be detected.

Results also suggest that the incorporation of such a platform into institutional offers, e.g. into youth work organisation, could be beneficial, for both the youth workers as for the young people.

6. ACKNOWLEDGMENTS

We would like to thank our project partners of “ComeIn” who work together as a collaborative team across Europe and who have made it possible to carry out our study.

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Applications

Short Papers

A Mobile-Based Group Quiz System to Promote Collaborative Learning and Facilitate Instant Feedback

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Abstract

In this paper we develop and evaluate a mobile-based questioning-answering system (MQAS) that complements traditional learning which can be used as a tool to encourage teachers to give their students mobile-based weekly group quizzes. These quizzes can provide teachers with valid information about the progress of their students and can also motivate students to work in a collaborative manner in order to facilitate the integration of their knowledge. We describe the architecture and experiences with the system.

Keywords
Mobile learning, m-learning, mobile quiz, group quizzes.

1. INTRODUCTION

Modern communication technologies and mobile devices are revolutionizing our lives and business practices [1]. Wireless networks and mobile technologies allow the instant exchange of data anywhere in the world. Data includes text, voice, video and animated images. Undeniably, each generation of technology can mould educational development in its own image [2]. Consequently, the use of such technology plays a crucial role in the learning process. The prolific mobile phone can be indispensable in supporting mobile learning potential [3]. A Portio Research report found the overall, the mobile phone penetration rate will be 75 per cent by 2011 as a direct result of increasing mobile phone users, which may reach around 1.5 billion. Additionally, 65 per cent of these 1.5 billion new consumers will come from the Asia Pacific Region [1].life is rapidly change, people adapt to this rapid change of lifestyle in different ways. Meeting the requirements of daily life can pose significant obstacles to seeking classic education. Seeking further education can be expensive, even unaffordable. Disengagement from education has risen considerably. This may correlate with an increase in illiteracy. This complex issue can impact entire communities. Therefore, great effort is required to counteract and control this important phenomenon. Potential solutions to this issue must consider the mobility and personal characteristics of potential education seekers. Increasing availability of educational options may not be constrained by physical boundaries [3]. That is, education can easily take place provided the learner is eager to learn [4]. A study conducted by Vavoula on everyday adult learning episodes found that, from a total of 161 learning episodes, 51 per cent took place in an environment familiar to the Learner such as the home or workplace. Other findings in Vavoula's study showed that:

- Two per cent took place at a friend's house
- Five per cent took place outdoors
- Six per cent took place at place of leisure
- 21 per cent took place in the workplace but were separate from the immediate work area
- 14 per cent took place in other locations such as places of worship, the doctor's surgery, cafes, hobby stores and inside cars.

Fascinatingly, one per cent of the self-reported learning took place on transport. This highlights the possibility of using transport, such as trains or buses, as portable learning environments in which students can use commuter time to study. This environment may present real-life episodes that stimulate learning and encourage an expanded perception of how to deliver and receive education [1] [2]. M-Learning allows students to use their unproductive time to pursue extra education. It can also be applied to specific formal and informal educational situations to increase the learning experience. M-Learning is an influential technique that engages students in an environment familiar to them. It is particularly effective for non-traditional learners or large groups who are unable to participate in classroom-based learning. Indeed, M-Learning plays a crucial role in opening new possibilities to extend educational opportunities. Mobile assessment can be also a great option which can be used to encourage students to work together regardless of their physical locations [5].

The focus of this paper will be on using the mobile phone for offering a mobile-based weekly group quiz to provide both the instructor and student with instant feedback, to encourage teachers to give their students mobile-based weekly group quizzes and to encourage students to work in a collaborative manner. Instant feedback is a powerful method to help the students immediately measure their understanding of a given class. Moreover, the instructor can also benefit from instant feedback as it indicates whether the concepts of a given class have been understood by students or not. From another point of view, learning in a collaborative manner allows students to benefit from each other's strengths. In this research, the researcher designs and builds a

Mobile Questioning Answering System (MQAS) to facilitate the transmission of instant feedback and to facilitate collaborative learning.

2. CONCERNS

Two concerns motivate our approach:

A. Due to individual differences between students in their level of understanding, some students may not be able to clearly understand the concepts imparted in a given class. So, students need a flexible method to help them work collaboratively in order to gain benefit from the knowledge of others in order to increase their understanding.

B. Teachers need to confirm whether the student has met the planned objectives of the given lesson. The instructor can achieve this by following a strategy of weekly quizzes. However, in a traditionally-based assessment forum, that being paper-based, the teacher's intent may be impeded by obstacles such as the process, being time consuming and inaccurate, and involving a huge effort in the case of a large class and the absence of instant results.

3. THEORETICAL BACKGROUND

3.1 Feedback

When it comes to education, feedback is a crucial part of the learning process as it provides both teachers and students with valid information about their performance. In this research, the emphasis is on the mobile-based weekly group quizzes as a method to provide feedback in term of marks which are facilitated by MQAS. Both teachers and students can benefit from the results of these weekly quizzes. These mobile-based weekly quizzes focus on the objectives of each lecture, meaning that learning objectives of each class will be converted to the form of questions to be given to students as a quiz. So, these mobile-based weekly quizzes cover the necessary learning objectives that students have to meet in order to understand the content of a specific class. Teachers can use them as valid measurements to assess and evaluate the quality of their teaching. Also, weekly quizzes can be seen as a guide for teachers, providing them with information on how and why students understand or misunderstand the concepts imparted in any given lesson. Moreover, quizzes play a vital role in identifying the parts of the lesson which should be explained again, or given extra emphasis. Instant feedback also helps teachers to develop suitable academic strategies to deal with students who have academic problems.

Students also may benefit from instant feedback provided by MQAS. These quizzes can be viewed as a guide to help students understand their weaknesses and help them assess their understanding of a given class. Also, quizzes can assist the student to early recognize the objectives of given class as it will be covered in the given quiz which is given at the end of each lecture.

Traditional paper-based quizzes may be more difficult to implement, being time-consuming, inaccurate, requiring an enormous effort in the case of large classes and lacking in instant results. However, the MQAS can address these drawbacks. The reason is that MQAS easily allow teachers to construct these weekly quizzes and send them to their students' mobiles. Most importantly, teachers do not have to bother themselves with correcting these mobile-based weekly quizzes. Teachers simply have to wait for the results of the quiz which will be automatically produced by MQAS. The most significant feature of MQAS is that it allows students to do the quiz using their mobiles, so there is no restriction at all, meaning that students do not have to sit in front of computer for a specific time to answer questions on a given quiz. Furthermore, students do not have to wait for weeks to obtain their results as the result of their quiz is sent to them instantly upon the completion.

3.2 Collaborative Learning

Working together in groups defines collaborative learning, its major attributes including the supply of common problems or suitable tasks for the group to work on, facilitation of small group learning, developing cooperation, interdependence and individual responsibility as well as fostering responsibility between group members [6]. Here, social interaction is encouraged to allow students to learn from each other's strengths. The group activity aims to support friendship, brotherhood and team work. In a collaborative environment, the teacher will only serve as a facilitator who provides support and guidance but does not necessarily interfere directly with the learner's natural setting. This role of the teacher, which is to help the participants or learners develop appropriate cooperative behavior, should encourage learning outcomes. In fact, social interaction through collaboration is essential in developing an effective learning environment as it supports high-level critical thinking skills, as well as individual and group responsibility. The MQAS aims to facilitate collaborative learning as it involves mobile-based weekly group quizzes for students, where the students will be asked by teachers to form groups in order to do the quiz, using their mobiles in a collaborative manner. The quiz will only be sent to the leader of each group, meaning that, the quiz will be running only on the leaders' mobiles. Sending quizzes to leaders could be an effective tactic to increase the connectivity and interactivity of groups as leaders will need to relay the questions of a given quiz to the members of their group. Therefore, students are required to talk in order to answer the quiz, so that answering the quiz questions becomes the central aim of this particular group activity. In contrast, if the quiz is sent to all group members, the interaction between members could be greatly reduced because each one will be able to easily read the quiz directly from their own mobile. MQAS could be an effective way to encourage students to work together. Three reasons support this view. First, students use their mobiles to do the quiz, meaning that students will be able to do the quiz at any time, in any place. Second, the quiz which is a task with which students are very familiar can be considered as a transformation from individual to group work. Third, it is well known that a quiz is a graded task which affects students' academic path. In the case of the mobile-based group quiz, any member of the group will have the same mark as the group's mark, meaning that the mark will be shared by group members. Sharing the same mark is a critical point which can play a major role in increasing the level of interactivity and the responsibility among each group. The level of difficulty of the quiz should be appropriate to suit group activity. Indeed, with the presence of the teacher as facilitator to guide the learners in the process of performing the learning activities and with the help of peer collaboration, it is likely that learning will occur. In the study of Sthapornnanon and Theeraroungchaisri, it is emphasized that students learn best when they actively construct their own understanding though social interaction with peers [7]. From here, they are encouraged about self-discovery in terms of solutions and ideas. MQAS intends to encourage collaborative learning through the implementation of group activities.

4. THE CONCEPT OF MQAS

MQAS is generally made up of two different parts interacting with each other to facilitate the mobile-based group weekly quizzes. The first part is the client-side mobile-based application which runs on students' mobiles .The client-side is programmed by using a special version of Java called Java micro edition or Java ME for short. The main purpose of having this application and making it run on students' mobiles is to benefit from the mobility of students, in which case, they can easily interact with it regardless of their physical location. The second part of MQAS is the server-side which is a web-based application programmed using VB.NET with ASP.Net 3.5 technology to build the website. The server-side plays a key role in providing teachers with an easy way to remotely set up the quizzes and monitor the performance of their students. Most importantly, the server-side is responsible for automatically correcting the questions and providing instant results without any intervention from teachers.

5. THE CONNECTIVITY BETWEEN THE PARTS OF MQAS

MQAS relies heavily on SMS protocol that is used by both side the client and the server to communicate with each other, especially for students to send answers. In fact, in this system, the SMS protocol is purposefully chosen as a stable way of exchanging information between the two parts of the system. In this regard, the expected question to be asked is why the SMS is preferred over other ways such as using the Internet. The reasons behind this are as follows:

First, SMS is provided by telecommunication companies as an essential service. So it does not have to be ordered separately as in the case of the Internet services in some countries. Second, it is supported by any kind of mobile device; also it is a relatively inexpensive service. Third, its network is highly reliable; also it does not suffer from frequent disconnections. Most importantly, SMS messages can be addressed to a specific port, so that different applications can communicate on dedicated ports.

Indeed, MQAS aims at minimizing the use of the Internet to avoid any connectivity faults which cannot be predicted which may play a major role in causing many disturbances during the quiz. Most importantly, the quiz has a limited time to be done, meaning that students have to start at a specific time and end at a specific time so any connectivity faults are not acceptable and may prevent other students from completing the quiz. However, MQAS makes use of the Internet for one purpose, which is to download the XML file which contains the quiz from the server-side of MQAS using the Internet. Downloading the quiz from the server-side of MQAS using the Internet will not take a long time because the size of the quiz file is very small. From practical experience, the client-side collaborative quiz requires only five seconds to download the XML file. After downloading the quiz, the Internet connectivity is not needed any more. The rest of the communications will be via SMS text messages which are more stable than the Internet. We use the Internet in order to overcome the limitation on the number of characters that can be sent in each SMS text message. Each SMS messages can consist of up to 160 characters at most which is compressed into 140 bytes which is not enough for a long quiz. Even in the case of concatenated SMS, giving a long quiz is not a practical method to be followed as this method has to be supported by the cellular network industry and mobile phones, in order to function in a proper way, making it very costly and limited.

6. HOW MQAS IS USED

We explain below how MQAS is used:

1. In the beginning, students have to be divided by the teacher into groups. Each group has to have a leader who can be elected by students or assigned directly by the teacher. Figure 1 illustrates the class division.

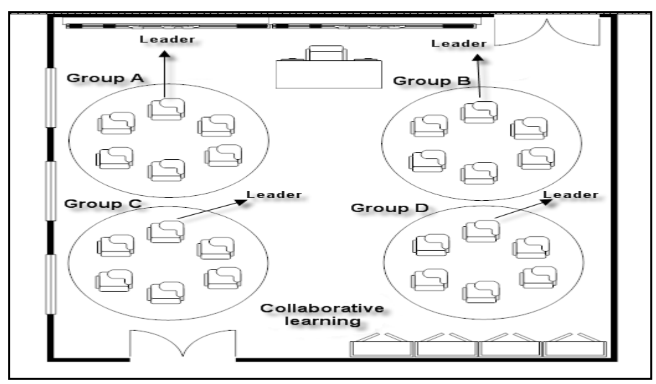

Figure 1: the division of class

2. The client-side collaborative quiz has to be preloaded to the group leaders' mobiles before doing the quiz. A specific text message will be sent to their mobiles by the teachers which contains the URL which leads to the place of XML file.

3. Upon receiving the SMS message, the client-side of MQAS will automatically trigger the client-side and trigger loading of the

XML file which is saved on the server-side of MQAS using Internet connectivity.

4. Upon downloading the quiz, each group is required to start answering the quiz in a collaborative manner.

5. After finishing answering the questions as a group, the leader of each group will send group's answers in the form of an ordinary SMS message to the server-side using the client-side of MQAS.

6. Answers will be corrected in the server side.

7. Feedback is sent in the form of percentage as text message to each leader of group.

8. Quiz's questions and answers are emailed to each groups' leader along with groups' answers.

7. EVALUATION

7.1 The Context Of The Study

This study was conducted at La Trobe University in Australia. For the purpose of this study, the subject, Mobile Pervasive Computing (CSE4MPC), was chosen. A part of this subject involves mobile technologies and designing an application that can be used on mobile devices. The reason for choosing this particular subject is that students involved in this subject are more likely to be familiar with the applications of mobile devices. This familiarity on the student-side helped in overcoming the time limitation problem, as this study had to be conducted over a very short period of time.

7.2 Participants

For the purpose of this study, two groups of postgraduate students participated; all of them hold Bachelor of computer Science. Each group consisted of three members including the leader. Students involved in this study participated voluntarily. The two leaders were elected by the students involved in this study. Each student joined their preferred group.

7.3 The Procedure

For the purpose of using the MQAS to answer the paper questions, the researcher followed the steps outlined in point number 6. The three quizzes were give in this study were written by the teacher of the subject. The nature of every quiz question was linked to the objectives of every lecture. In other words, the objectives of a given lecture were converted into a question form to be given to the students in the quizzes. Most importantly, all three given quizzes were given outside of the assigned class for the chosen course; one of them was done in the main library. The purpose of doing this is to increase the freedom of both teachers and students.

7.4 Instruments

Two interviews were used at the end of this study. One was used with students, and the other was used with the subject's teacher. Also, observation was used in this study. The researcher attended the three classes in order to observe the process of how students used the MQAS.

7.5 The Study Findings

The qualitative analysis of the sources of data resulted in answers to three questions:

1. Does the mobile-based questioning-answering system facilitate the implementation of the collaborative learning theory?
2. What are the benefits of using a mobile-based questioning-answering system to provide students with instant feedback?
3. Does the mobile-based questioning-answering system help teachers construct weekly quizzes in a convenient way?

Questions 1 and 2 were answered by the students' responses to the interview questions. The interview consisted of six questions: two related to collaborative learning and one related to the benefits of instant feedback provided by MQAS. The remainder investigated the benefits of this approach.

Question 3 was answered by the teacher's responses to the interview questions directed to him. My own reflections (gleaned from the observation sessions) will be used to support the answers to the paper questions.

7.6 Students' Reflections

Based on the students' responses to the interview questions concerning the first question, the first problem was, to some extent, solved by using the MQAS as it encouraged students to work collaboratively to gain benefits from each other's knowledge. A noteworthy finding is that students liked the mechanism of sending the questions to the leader of the group, as it compelled them to talk objectively with each other in order to answer the questions in the quiz. This important feature of MQAS helped increase the interactivity and connectivity among the groups.

The second paper question was included to determine the value of instant feedback provided by MQAS, this question was answered by students. Based on the students' responses to the interview questions concerning the second question, it can be seen that students obtained huge benefits from the instant feedback facilitated by MQAS, as it helped them realize the points in a given class that they have or have not understood.

7.7 Teacher's Reflections

The last question was added in order to determine the benefits that the teacher obtained from using the MQAS. Based on his responses to the interview question, it is clear that he was pleased about this system as it helped him manage the weekly group quizzes and monitor students' performance with fast feedback.

7.8 Researcher's Reflections

I (the researcher) attended all three trials of MQAS in order to observe the performance of students. In order to increase the seriousness of these quizzes, the winner was promised to be rewarded. The points that I observed during the trials are as follows:

First, students seriously discussed the questions with each other in order to ensure their answers were right to be competitive against other groups. Second, Mobile-based group quizzes encouraged them to talk, to participate and to discuss and elicit their ideas, the mechanism of sending the quiz to one mobile (leader's mobile) was successful as it encouraged students to talk objectively with each other. Third, one of the participants could not attend the lecture, but he told me at the end of the quiz that these mobile-based group weekly quizzes helped him better understand the concept that was relayed in the class that he could not attend. Fourth, one of the participants, after receiving feedback which was sent as a text message, told me that he would consider this mark as a wakeup call, because previously, he had no idea that he was not on the right track.

8. RELATED WORK

Currently, handheld devices are being widely used in education as an instruction tool for learning. Many researchers have proposed different ways of using handheld devices in education. For instance, wireless access to online resources allows students to obtain information from the Internet using their mobile. Also, it has been used to increase the interactivity of the ordinary classroom, to increase the level of thinking of the student by using educational games, and to obtain situational information such as what can be noticed in fieldwork studies. Furthermore, handheld devices have been used to serve many purposes such as language learning, music education, student reminders and personal timetabling, work-based training and lifelong learning. All of these approaches are based on a different kind of technology of handheld devices.

In this paper however, we focus on the systems that provide quizzes to motivate learners to obtain benefit from the mobility of the mobile devices and also on the systems which follow the question answer kind of relationship. For instance, in [8], the mobile quiz system aims to facilitate information-sharing through quiz challenges posted on the 3G mobile phones of pre-registered users. Also, in [9], users are provided with lessons to enhance the reading comprehensions for students and at the end of each lesson, there will be a group of questions that should be answered to proceed to another level. Moreover, in [10], the developed mobile application is used by students to access to the server to download the tests which are about many subjects and also these tests have three levels of difficulties. The application has tow modes being single and group mode, the player can play until he finishes the available test; the feedback is provided with some funny faces. Also, in [11] learners can send an empty mobile email to the server side along with the subject name in order to request the test to be email to his/her mobile. After receiving the test as an email, student will answer the given test, and then they should replay to the email by typing the answers and sending them back to be corrected and to get the feedback. However, they do not facilitate group quizzes in the same way as we do here. In which case, the MQAS is only running on leaders' mobiles to maximize the positive participations and to facilitate the human interaction between students as mentioned before.

9. CONCLUSION

In conclusion, although the present study may have some limitations, it provides useful insights into the benefits of MQAS as a quiz platform; it gives a general picture of the results of using this system as a tool to encourage students to work collaboratively; and it illustrates the benefits of providing students with instant feedback and a weekly mobile-based group quiz, as well as feedback to teachers regarding students' understanding of lectures. The convenience and usefulness of issuing frequent and regular quizzes via the mobile phone channel cannot be underestimated. Of course, more extensive research could be done, based on the present study, with the goal of promoting the use of mobile devices for educational purposes on a larger scale.

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Being a Geographer: the role of mobile, scripted inquiry in mediating embodied meaning-making during Geography fieldtrips

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Abstract

Geography fieldtrips are often described in terms of providing learners with first hand experience of the natural world. However, this perspective of fieldtrips takes for granted that learners will engage in certain types of 'given' practices, such as data collection, writing notes and the taking of photographs, and fails to look closely at such activities in terms of how they constitute what it means to be a Geographer and to engage in evidence-based inquiry. We have developed the notion of scripted inquiry learning. A script is a web-based inquiry plan, navigated by students by using Activity Guide, which they accessed in the field via mobile Asus Eee netbooks. We report on two studies carried out in 2008 and 2009. Each study was carried out with a large cohort of 14-15 year old school students investigating urban heat islands. Our analysis of transcripts of the student's dialogue during the fieldtrips draws upon the work of Goodwin (2003). Our findings illustrate how Activity Guide mediated the students' engagement in a process of embodied meaning-making which involved, for example, dialogically transforming their environment into semiotic objects (e.g. building materials and traffic pollution) and physically interacting with the environment so as to describe it in terms of evidence using appropriate terminology (e.g. degrees Celsius and infrared irradiance levels) and in so doing defining what they understand to be the features of an urban heat island and what it is to investigate them. We conclude that Activity Guide helped the students to organise their data collection and supported them in being Geographers.

Keywords

Scripted inquiry, embodied meaning-making, mobile technologies

1. INTRODUCTION

In this paper we discuss the embodied learning experiences of young people (aged 14-15 years old) during their Geography fieldtrips in which they investigated urban heat islands (identifiable when the air temperature in a city centre is higher than that in the suburbs). The aim of the fieldtrip was for students to collect data from an old, crowded, traditional town with relatively narrow streets (Northampton, UK) and to compare it with data collected from a new town which was deliberately planned to have open spaces, wide roads and commercial buildings of limited height (Milton Keynes, UK). We report on two studies carried out in 2008 and 2009 by the Personal Inquiry project which has developed the notion of scripted inquiry learning to support students and teachers through the inquiry process. The scripts (see section 2.1) are web-based and hence accessible via mobile technologies during fieldtrips.

Geography fieldtrips are promoted as being of benefit to students for a number of reasons. They can give students first-hand experience of geographic phenomena (e.g. Cook, 2010), help them to consolidate classroom learning and can be an opportunity to practice the application of practical skills (e.g. Lai, 1999). Also, fieldtrips can help students to gain a better understanding of the discipline of geography in terms of vocabulary, methods and techniques, and may also provide opportunities for the development of interpersonal skills and environmental values (e.g. Kent et al. 1997). Mobile technologies are particularly suited to supporting the needs of students on fieldtrips as they can mediate contextually situated activities on-the-move. For example, young people can identify birds as they are observed in the field (e.g. Chen, 2003) and undergraduates can identify species of fish whilst snorkeling (Pfeiffer et al. 2009).

However, despite the contextually embedded nature of the learning experiences discussed in these papers, their approach limits the opportunity for researchers to explore how new understandings and identities emerge from learners' embodied participation in performative and discursive activities in physical and social worlds (e.g. Miell and Littleton, 2008). Also, in many studies supported by mobile technologies, the approach most often adopted is one which asks 'what can the technology do?', rather than 'how can learners use the technology?' So, evaluation may focus on problems with the technology or how various features of the technology were used (e.g. Song, 2009). Exceptions include Solé (2009) who prioritises analysis of the activities in which language learners engage whilst participating in foreign cultures. She quotes Kramsch (2002) who defines "language as emerging from a person's situatedness and participation in a physical and social world" (p11). Solé argues that spaces are not the backdrop against which action takes place, but "they become part of the lived experience, they become personally experienced spaces" (p 140). This perspective aligns with that of socio-cultural psychological theory, which we discuss next.

1.1 Theoretical perspectives

Descriptions of the advantages of fieldtrips, as outlined above, tend to take it for granted that learners will engage in certain types of 'given' practices such as writing notes and taking photographs, and fail to attend to how embodiment (i.e. situated co-constitutive action) is a central component of the activities used to build meaning in the field. Goodwin (2003) gives an account of how an archaeology tutor uses a trowel, gestures, gaze and dialogue to transform patches of different coloured earth at an archaeological site into culturally appropriate categories and, in so doing, defines for the learner what it is to be an archaeologist and to practice archaeology, suggesting that such practices need to be learned and applied appropriately. Wertsch (1991) reminds us that "when action is given analytic priority, human beings are viewed as coming into contact with, and creating, their surroundings as well as themselves through the actions in which they engage" (p8). From this perspective mind "extends beyond the skin" (p14) and the preferred unit of analysis is individuals-using-technology-in-settings (Crook, 1994). It appears as though this perspective of mediated embodied meaning-making is rarely used to describe Geography fieldtrips

In this paper we begin by reporting our analysis of the dialogue of groups of students on the fieldtrip, we then look in detail at one short data gathering activity (further examples will be included in our presentation) and illustrate how the students' engaged in a process of embodied meaning-making.

2. Methodology

Four fieldtrips took place, two in 2008 and two in 2009. The students were all studying for their national qualification: General Certificate in Secondary Education in Geography. Twenty per cent of their grade was based on an extended piece of coursework which is in the form of a report on their fieldtrip (the remaining 80% is by examination). The students were divided into groups and first walked across Northampton town centre and collected data from 12 preset locations. Then they travelled to Milton Keynes and undertook a similar activity there. Each group was accompanied by several teachers and researchers. Two groups of students wore microphones and were filmed in 2007 and four groups were filmed in 2008. We report on data from all six groups, with a carefully selected representative example to illustrate our main points.

2.1 nQuire and Activity Guide

The Personal Inquiry project has developed the notion of technologically-supported scripted personal inquiry learning. A script is web-based inquiry guide and is implemented in nQuire (www.nQuire.org.uk). A script implements an inquiry in terms of phases (e.g. choose my method or analyse my data) and associated activities (e.g. select my equipment or select data to analyse) which take place across temporal phases (e.g. lessons or weeks). The students navigate through their inquiry via an Activity Guide so that, for example, they can click on 'My Method' and choose their equipment or measures (Figure 1). The urban heat island script was accessible to the students via, in this case, Asus Eee net books in the field and desktop machines in the classroom and at home.

The students used Sciencescope data loggers and sensors (http://www.sciencescope.co.uk/) to collect environmental data such as air temperature, carbon monoxide, wind speed and infrared irradiance, and also plotted their route using GPS readings, and took photographs. They walked a planned route across two different towns – Milton Keynes and Northampton – and collected data from 12 stops in each town on the same day. These towns were chosen as one was the students' home town and the other contrasted sharply in terms of age and planning. Asus Eee net books were selected for use as they are light enough to carry outside for long periods and have a relatively long battery life, whilst also supporting text input via a mini keyboard to screens large enough to aid a clear representation of content. The aim was to investigate whether there was evidence of an urban heat island in either town, and how differences in land use across the two towns may have impacted upon this.

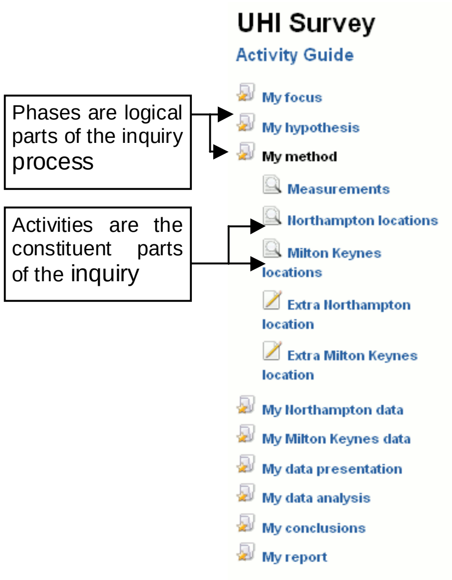

Figure 1: Annotated screenshot of Activity Guide

3. Analysis

Transcripts of the students' dialogue during the fieldtrips were analysed thematically using the qualitative analysis tool Atlas ti. Emergent themes were identified and coded. Our aim here was to identify the basic components of the students' dialogue in terms of different types of utterances, such as questions and responses, and their content. Once this was complete we represented a data collection episode as an annotated series of stills from the video footage and drew upon Goodwin's (2003) approach by analysing the talk, gaze and actions of these students as they worked in the field.

4. Findings

Table 1 illustrates the types of task-related dialogue that we identified as occurring across all four groups of students during the four fieldtrips and suggests that most discussion focused on the collection and recording of data. Given the town centre locations and the range of possible topics that could have engaged the students (e.g. goods in shop windows, their favourite brand of car), the students' dialogue was very focused on the task in hand. In the following sub-sections, we take a close look at the types of dialogue identified in Table 1 and discuss how the students were engaged in associated embodied experiences and how these were mediated by nQuire.

Table 1 shows the types of dialogue that the authors of this paper chose to foreground; the table does not illustrate the

Utterance	%	Examples
Calling out data readings	39	"seven point four degrees"
Asking for a data reading	24	"what is the air temperature?"
Descriptions of qualitative data	11	"It's industrial"
Monitoring and management	9	"we are done here"
Asking for help with qualitative data input	7	"what shall I write ?"
Instructing where and how to collect data	5	"take an IR reading from that wall there"
Asking where to collect the data from	3	"do we want a reading from there?"
Interpretation of data	2	"as buses go past the CO rises"

Table 1: types of task-related fieldtrip dialogue

various types of casual discussion that took place amongst the students whilst they were walking between their data collection points, or that which occurred at each point. Indeed, the discussions between points were not recorded unless the students spontaneously started to talk about their fieldtrip in any way (this was very rare) and casual dialogue at each data collection point was not transcribed (it was documented as a period of 'general chat'). Whilst the students' general chat is not important to our understanding of their data collection activities, it does however indicate how these students were switching between different genres of dialogue: from general chat to that associated with being a young Geographer. We suggest that this indicates their awareness of different genres and their appropriate use of language whilst adopting different roles (friend and geographer).

4.1 Situated dialogue and embodied meaning making

In this section, we consider an excerpt of dialogue from a group of five female students who were collecting GPS readings, air temperature, infrared irradiance (IR) (heat energy being emitted by surfaces), and they were taking photographs. This excerpt is not special in any way; it represents a regularly occurring data collection episode at a data collection point. The location was labeled in the Activity Guide as 'All Saints Church'. The students arrived here and found themselves in a large square, bounded by roads on three sides and a large church on the fourth side (see Figure 2. The circle indicates were the students stood).

The sequence of the students' activities at this place, and their dialogue is illustrated in Figure 3 (this representational style was inspired by that used by Goodwin, 2003). In frame 1 the student taking IR readings asks whether she should take a reading from a lamp post and the student holding the laptop advises against that and suggests (frame 2) that a pillar that is part of the building is more appropriate.

This brief interchange establishes that, of all the possibilities, it is the *building* which is important to these students (they could, for example, have taken an infrared irradiance reading from the pavement). This short dialogic

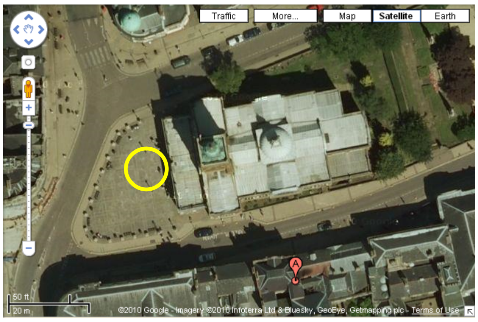

Figure 2: Google Map of the data collection point

interchange transformed a church building into an object of inquiry: the students conceived a once familiar cultural artefact not in terms of its role, for example, but instead reconceptualised it into a structure that may emit heat energy and thus contribute to an urban heat island. In this example, infrared irradiance constitutes part of the cultural semiotic landscape (Goodwin, 2003) of the Geographer in this setting.

Similarly, air temperature (frame 5) and the students' interpretation of the impact of sun/shade, open space and traffic (frame 6) all contribute to defining this place in terms appropriate to a Geographer. The students' use of Activity Guide at this location (and others) worked also to strengthen this perspective as the data collection screens consisted of text boxes and drop down menus to support these young peoples' understanding of which data to collect or, in other words, which features of the location to focus on for the task in hand.

Goodwin (2003) argues that "determining what counts as cultural (and thus something to be recorded and brought back to the lab in some fashion) is by no means an automatic, or even easy task. In order to see and accurately map the features that are the focus of her work, a young [geographer] must navigate a complex perceptual environment" (p4) The young Geographers depicted here are participating in a contextually, and culturally, embedded interpretation of the environment and are using Activity Guide to support them in selecting which features to note as relevant and which to ignore.

The students' experience at this location, as depicted in Figure 3, is embodied in that they are interacting *with* their environment: they are pointing a sensor at a pillar, talking about the appropriateness of collecting data readings from a lamp post, walking about the open space in front of the church, looking at the church and taking photos of it, measuring the temperature of the air and recording a GPS reading of their precise location on the Earth. They are contextually embedded and the mobile nature of their technology supports them in making sense of where they find themselves to be in a way which is culturally relevant for their role as young Geographers. The students also exercised choice over which photographs they took and which text to write in the free text 'notes' boxes in Activity

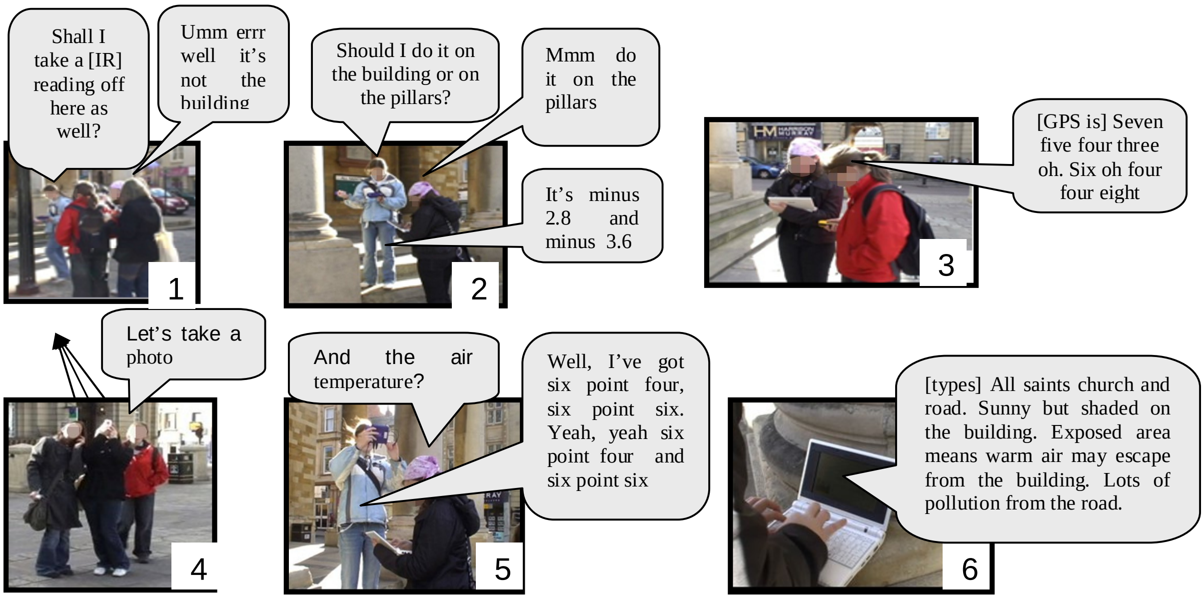

Figure 3: Annotated video stills

Guide. Figure 3 (frame 4) depicts three of the students jointly attending to the collection of photographic data from the church building. It is clear (in the video) that they are all looking at the church building and once the photograph is taken they looked at the camera's digital display to check the quality of the image. The students' choice of photographs, text, and IR readings are shaped by an expectation of what the data will reveal (e.g. Goodwin 2003 and Roberts, 2010) and what it is the students need to do.

5. Conclusions

We have applied Goodwin's (2003) analytic approach to analysing embodied meaning making to help us to understand students' activities during a Geography field trip. Our methodology has enabled us to analyse the dialogic and performative aspects of students' activities through which they define the domain they are investigating *and* what it is to be a Geographer. We have illustrated how students make sense of their environment and in so doing reconceptualise everyday artefacts in geographical terms. This approach goes one step further than describing fieldtrips just as an opportunity to gain first hand experience. Our approach has illustrated how the students used Activity Guide, accessed via mobile Asus Eee net books, to support their contextually embedded meaning-making activities in the field. Our findings support Wertsch's (1991) claim that individuals shape their surroundings as well as themselves through immersing themselves in culturally-relevant activities. We argue that Activity Guide was effective in supporting the students' understanding of how to be a Geographer.

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Students as a Source of Mobile Learning Resources: the Student Becomes the Teacher

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Abstract
The focus of the work is on the use of short multi-media podcasts used for undergraduate teaching in a university business school. Podcasts have an established educational use for content dissemination. This paper also briefly reports their use for student assessment, as an alternative to written work. This helps build a learning community and improves engagement with the assessment process. However, in our experience, students do not make use of podcasts in mobile mode – for e-learning. Questions are raised about how to increase student interest in podcasts use, with particular reference to mobile learning. Experiments are proposed to test motivation and hygiene factors that may be relevant to increasing student use of mobile-learning.

Keywords
video podcast, learning community, university assessment.

1.INTRODUCTION
The UK business school that this work relates to has a wide range of undergraduate and postgraduate courses, each comprised of a number of units taken by each year group. As a result of the mix of professionally oriented and generalist components we have some units with many hundreds of students, and others with a few tens. The larger units present particular difficulties, and provide focused, utilitarian, motives for the development and use of multi-media podcasts. The focus in this paper is on the application of podcasting to a smaller teaching unit where the use of podcasts is driven by different motivations. Podcasts are produced by students, used as a vehicle of assessment, then used to teach subsequent groups of students.

This is an action research project that has been in operation since 2006, and has been regarded by staff, students, and the university as successful from the outset (Scown, 2008). Work on the use of student- made podcasts is described, and questions posed as to how this work might be further developed by making mobile learning more mainstream for the target population of students. However, there is room for improvement as take-up of mobile learning opportunities has been low.

2.BACKGROUND
The main activity of the project centres on student-produced video in the context of a final level elective relating to human factors and information technology, and which runs across the Business School. Increased availability of video production tools (both software and hardware), plus an increased profile of video podcasting, were instrumental in triggering the described change to student assessment. This was in a context of a teaching philosophy based on maximising student engagement through:

- Increased student ownership of the assessment process,
- Increased variety of learning experience, and
- Increased opportunities for being creative.

The availability of the technology, in the context of the tutor's philosophy, led to the design of an assessment based on student production of video, rather than yet another written assignment. Students would be allowed to demonstrate their understanding of key concepts, and to demonstrate skill, through the production of a short video, around ten minutes in length. From the outset it was made clear that "broadcast quality" was not required. However, it was necessary to be able to see and hear what was meant to be seen and heard. Creativity was encouraged. Although each student has to appear in their own video they were discouraged from making "talking head" productions. The results have been encouraging. Students have engaged with the process of being creative. Video has been produced out in the wider world, so that concepts can be linked to real-world behaviours of the population at large; potentially dry, academic concepts were made real.

Most of the podcast work that was submitted was usable in terms of "production values": video was clear enough, sound was audible. There were some production problems. Poor lighting left some situations in silhouette, so that the useful content was lost. The most problematic issues were with sound. Where students switched locations, and used different recording devices, sound levels could drop considerably. This meant that when sound dropped away the volume of the playback device had to be turned up. This is not a problem, until the volume level returns to normal – at which point it becomes painfully loud. Some of these problems, e.g. lighting, stem from the non-cinematic backgrounds of the students; others, such as sound levels, could be rectified with improved mastery of the technology. However, overall, a useful set of resources has been produced. To date, approximately forty useful podcasts have been produced by students, depending on where the threshold is set for academic content and equipment capability.

As a concept that was new to the Faculty, and so untried, it was offered as an optional route to assessment. Students have been allowed, from the start of the project, to produce a written assignment, should they feel that this would best suit them. In addition, the option to produce a video is allowed forboth of the unit's assignments. For the first two years video was only allowed for the second assignment, after the students had established a base- line of performance and become familiar with the content and style of the unit. Students have reported that the assignments for this unit are fun and enjoyable – not a common experience for them.

Video produced for this project had four main purposes:

1. provide an alternative vehicle for assessment, adding intrinsic interest, and to allow students to be assessed either by written or video submission;
2. produce a set of resuable learning objects (RLOs) to support learning of later student cohorts, and thus…
3. develop and increased sense of a coherent "learning community", where "this year's students become teachers to those of the next".
4. improve student performance as reflected in higher grades and possibly pass rates, and
5. efficiently support the building of a resource library.

Work on this project commenced with the 2006- 2007 cohort, and continues to date. As an action research project the methods are evolving. This is a result of modification in the light of experience, and as a result of being able to draw on a library of previously developed RLOs that were not available to the first cohort. For the first cohort students were only given the option to produce video for the second assignment. This was to reduce risk, and to allow students and teaching staff to build the rapport necessary to support this novel approach. At the start, students choosing to produce video were better students. An analysis of marks showed that those students scored, on average, five percent more marks than students not choosing to make video[1]. Since the first use of this method, as it has become less novel, and as students are able to view the work of previous students, this differential has disappeared. There is now no significant difference between the marks of students choosing to make video and those that do not. In addition, the marks obtained for both type of video have converged. A differential of around five to seven percent has been found across several cohorts. These marks have been subject to internal and external moderation, so that we have some confidence that this represents actual achievement, and not marker bias towards the assessment method. However, students still find this work enjoyable, and give it high approval ratings.

The video podcasts are made available on a web- based streaming multi-media server. Currently there are 42 available that relate to the specific unit of teaching. Students can search the server by tag selection, or by typed keyword. Identified video can be selected and played, but is not readily downloadable. The web based access means that the podcasts are widely available within the university, using the wi-fi network. Alternatively, students may access the server from any location away from the University, so long as they have web access. Typically, students report doing this from home, where they have internet access established. A key factor in poor adoption of mobile use may be the cost of web access on mobile devices. While the podcasts may be accessed by web-ready mobile- phones, this would be a costly way to use the resources. A solution to this would be to make the video available in both downloadable and streaming formats. This would enable those students with adequate digital storage to save the files for use at any time, and without the need for web access.

The use of more graphic and interactive forms of student assessment has a basis in a wide range of pedagogic literature. Students experience learning situations in different ways. What they experience operates through at least two mechanisms: i) cognitive predispositions to types of learning (experiential, conceptual, etc. as described by Kolb, 1984); ii) affective: what one finds dull and uninspiring another may find interesting and engaging (paraphrased from Lucas, 2000). This suggests that a more varied approach will have a greater chance of reaching all of the students (at least) some of the time. A blended approach, a mix of on-line, text, experiential educational experiences, fits this requirement.

McFadden and Munns (2002) see the learning situation as a social situation, complete with social relationships (hierarchies, power relationships, etc). By allowing students choice about their assessment learners are enabled and empowered. In addition, in the making of a video they may be perceived as establishing a relationship with the students who will follow them in subsequent years: this year's students become next year's teachers. The work produced for assignments is explicitly public and to be published for the benefit of others. The publishing mechanism is on a podcast server within the University. Consideration has been given to more public arenas, such as youTube and faceBook. We have not previously considered using these locations due to the then relative immaturity of the technology, risks with tampering, spamming, and concerns with copyright. Now that sights such as youTube have matured and stabilised it may be time to consider them again. This would allow easy access from a variety of locations. In addition these are mainstream, and may be more prominent in student conciousness. Coates (2005) looks at engagement from a managerial perspective. Coates' view is that any quality assurance (QA) assessment should include measures of students' engagement. This may be measured by such factors as: attendance, retention, student ratings, student use of facilities for self-directed study, etc. If the work of Lucas, and McFadden and Munns (2002) is

[1] Rigorous statistical analysis is not possible: the number of students are relatively small, and the action research nature of the work means that variations in conditions between cohorts prevents controlled comparison.

appropriate to this context then engagement should improve. In such a situation there would be QA benefits seen as beneficial by management regardless of any other effects.

Pfeiffer et al (2005) propose supporting students in adopting the learning style appropriate to them. Within the HFBIS elective the assignments are considered to be a learning experience, rather than as a snapshot of what has already been learned. Students may submit work by text, or they may take a more visual approach through video. In addition, the video they create requires students to consider planning content, and consideration of audience in a different way than for written work. Video also provides an arena for students to experiment and to explore their creativity. The provision of written and video choices supports different styles. It must be added, however, that the provision of free choice means that students are also free to make the wrong choice. This could be argued to present ethical problems. However, if no choice were to be offered then some students would automatically be disadvantaged (although this would be the choice of the lecturer or the institution).

In the context of mobile learning we have a problem with technology that is moving so fast that identifying a stable platform for an extended study is impossible; it is even difficult for short studies. Corlett *et al* (2005) report demand for mobile learning – provided there is institutional support, and that the technology is easy to use. While the basic issue of ease of use is probably unchanged since that study, the means to achieve it have. Their work was conducted before the onset of large-screen mobile phones with touch-screens. McKinney *et al* (2009) report work suggesting that podcasts have considerable benefit to student achievement. However, in their sample, only 20% of those using the available podcasts did so on a mobile device. It seems increasingly possible that there are problems with mobility and learning that go beyond the availability of technology. One issue to be resolved relates to computer anxiety. Saade *et al* (2009) show a range of anxiety linked to computer self-efficacy". This suggests that e-learning, including mobile learning, will not be successful in student populations where computer self-efficacy is low.

3.CONCLUSIONS AND FUTURE WORK

There is a desire by university teachers to increase the uptake of e-learning in all its forms – including the very versatile mobile-learning. The educational community at large, and more specifically the mobile-learning community, have seen benefits in a range of situations. It is believed that once it is mainstream that it will enable students to be more flexible in their learning, potentially learning more effectively (e.g. McKinney *et al*, 2009), and making use of time that would otherwise be unproductive, for example, when traveling. What is needed is a set of techniques that will:

- support students who wish to use the technology,
- encourage more students to use the technology, and
- enable staff to support this effectively and economically.

Part of this is addressed in the current work. By using both teachers and students as content producers the process of podcast production is more efficient: more podcasts are available using this approach than if there was sole reliance on university academics. However, a number of questions remain unanswered. These include:

- What assumptions can be made about capabilities of the technology available to students?
- What range of multi-media formats need to be provided?
- How can multi-format generation of content be made efficient, how can administrative overheads be minimised?
- What are the constraints imposed by smaller displays and how can they be overcome?
- To what extent is computer anxiety present,and is it stable or altering in level?
- What are the motivators for podcast use, and
- What are the hygiene factors?

To explore this set of questions will require significant amounts of data collection. In the next phase of this work only a sub-set of the above questions will be considered. The focus will be on hygiene factors, as defined by Herzberg (1964). The motivation for making and using multi-media in learning can easily be seen. However, will this be held back by poor interfaces, costly access (e.g. by mobile phone network) and cumbersome administration?

A starting point will be to examine the format of available podcasts. It is proposed that the current video resources be made available in both streaming and downloadable modes. In addition it will be necessary to collect data on the number and frequency of accesses using each mode. Ideally, we would also like to collect data linking specific students to specific types of download. This would enable us to see if one mode of access has better learning outcomes than the other.

4.ACKNOWLEDGMENTS

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Mobile Collaborative Learning

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Abstract
In this article an approach for collaborative mobile learning is presented. Yet, we do not focus on the use of mobile technologies, which enable mobile learning in general, but on the mobility of the co-operating individuals or groups themselves. The respective collaborative acts in a learning environment, but the curriculums that are provided are determined by the reciprocal, changing locations of the members. The notion that mobile learning is not only a technological advance, i.e. a further development of formerly stationary information technology, forms the basis of this concept. Ultimately, after the formal definition, the proposed approach is explained by the use case of a nature trail.

Keywords
Co-operative m-learning, Collaborative m-learning, Education, Sequence-based m-learning, E-learning

1. INTRODUCTION
The learning mode has undergone a tremendous change from classroom lecture dependent learning to learner-centered interaction (ZHU 2002) with the advent of the Information and Communication Technologies (ICTs), introducing shift from a passive to an active learning mode (Ball 1990). E-learning, including mobile learning, has brought a changes to the process of learning.

The assumptions in traditional mode of learning are that the teacher knows everything, chooses to deposit, and assuming his authority leads to the alienation and disempowerment of the learner (Freire 1994). Importantly in this mode of learning, the process is dependent on time and place scheduled for a class.

E-learning facilitates the need to change away from traditional learning modes to more innovative and participative ones (Forman et al, 2002). E-learning supports the paradigm shift in learning as suggested by Pond (2002).

Today's challenge is that education must move to innovative and inclusive ways and that e-learning provides the flexibility and diversity that affect the shift from presence-learning location-bound to open flexible and life-long learning (Ball 1990). The use of ICTs offer help to improve the performance of learners with the help of better access of both teachers and students to the resources through electronic media (Larson and Bruning, 1996; McCollum, 1997).

Kramer (2000) describes that there has been a significant increase in interest on e- learning environments by both the academics and practitioners. Hijazi (2004) argues that the problems associated with traditional educational environment such as geographical isolations, schedule issues and unavailability of courses can be easily resolved with the help of proper design and management of electronic systems.

Mobile is one of the major advancements in communication technologies and a highly individualized as well as collaborative tool. It resulted in the concept of mobile-learning (m-learning) thought to be as an extension of e-learning concepts (Traxler 2005). However, this is only one of the aspects of m-learning.

It is an oversimplification that mobile devices are only an instrument that helps mobility independent of geographic location. This is overemphasizing the means to the end; the end is more of the learning process. The learning individual requires learning process that offers mobility based on heuristics such as 'sequenced based learning' (Lackes et. al 2009).

2. BASICS
When talking about aggregated experience in the field of m-learning, one has to have a look at the different topics this field of research embraces. This means that it has to be clear what is actually meant by mobile learning, co-operative learning and collaborative learning.

2.1 E-learning
With regard to the transfer of knowledge, respective control and the measurement of learning success are unspecified. E-learning imparts curriculum to groups and individuals non dependent on time and location. It serves to present and distribute digital teaching materials (Minass, 2002: 27). Leidner and Jarvenpaa refer to virtual learning as to the use of diverse information technologies such as IP

conferencing or distributed work spaces in order to transcend physical boundaries of the classroom and therefore annihilate spatial synchronism. The independence of time and location implies that learning becomes a continuous process. At the same time it can be suited to the individual learning requirements. Both the temporal progress and the intensity of knowledge generation can be harmonized with regard to the learning individual and lead to an improved education (Leidner and Jarvenpaa, 1995: 265 et seq.).

2.2 Mobile Learning

In recent years the propagation of mobile technologies advanced rigorous. Mobile devices and wireless data communication are almost ubiquitous. Hence m-learning is in the focus of attention as an emergent e-learning domain. The all out technical configuration of mobile devices caused e-learning to proceed on the go and thus use idle time in a reasonable manner.

The high accessibility of mobile devices can significantly improve dialogue control and as a result preserve time synchronism to a certain degree. For example, the questions of the learning individual can be answered prompt by ever attainable and qualified tutors or members of a study group.

M-learning enables people to acquire knowledge anywhere and at any time. However it is subject to the precondition that the learning process can be halted and resumed regardless of the location without any problems.

M-learning may be classified as location-based learning and/or sequence-based learning. Both forms are closely linked to a location or relocation and are characterized by a location-adaptive and/or situational learning process. With regard to location-based learning the curriculum adapt to the learning environment. The interactive museum guide is a popular example. Depending on the current position relevant information about works of art is made available to the visitor on his museum tour (Kusunoki and Sugimoto, 2002).

Both location-based learning and sequence-based learning are pure forms of contextual learning. Under the terms of such paradigm learning proceeds if the learning individual handles new information put in a contextual order, which seems sensible (Nygaard and Ib, 2004: 5). The context exists in situ. One may accept the depicted knowledge, which for this reason will have a quasi everlasting effect.

On this account it is of major importance to delve into the aforementioned forms of m-learning.

2.3 Collaborative and Co-operative Learning

Collaboration is the teamwork of two or more persons to reach a common objective. Therefore collaborative learning is the teamwork of several persons to reach an educational objective respectively to gain knowledge by interaction and working together with the group members (Paz Dennen 2000). This is based on the model, that knowledge can be transferred within a group by interaction in different roles between the team members.

Co-operative learning refers to group work on a structured activity where the members are individually accountable for their own work, and where also the teamwork of the group is estimated as collaboration. The assumption is that in those teams strong members can share their strengths to help weaker members to improve their skills (Millis 1997). Furthermore, it helps develop their soft skills like dealing with conflicts or find compromises.

3. Mobile Collaborative Learning

To transfer the concepts of collaborative learning and aggregated experience into the field of mobile learning, the taught knowledge shall not be determined by the sequence of visited points of interest, but the sequence of locations which the collaborative group has visited shall be influenced by the knowledge other members of the group gained at their points of interests.

At first a system for collaborative m-learning will be formally described. Then, the concept of collaborative learning is explored in more detail with a given example. Let

(1) $L_k = (P, C, K_B, sim, ref)$

be a collaborative mobile learning system with

(2) $P = \{p_1, \dots, p_N\},\ \ N \geq 1$

as the set of all points of interest p_n. A mapping ref assigns a value $r \in \{0,1\}$ to each tuple (p_n, p_m) depending on an existing mutual reference. It is

(3) $ref: P \times P \to R, (p_n, p_m) \mapsto ref(p_n, p_m)$

and $r_{nm} = 1$ if two points of interest p_n and p_m are interdependent. $r_{nm} = 0$ elsewise. In addition, a curriculum c_{nm} is assigned to each tuple (p_n, p_m) and

(4) $C = \{c_{11}, \dots, c_{NM}\},\ \ M \geq N \geq 1$

is the set of all curriculum. For $n \neq m$ knowledge about existing interdependencies is imparted, in case of a reference between two points with $r_{nm} = 1$. On the other hand, for $n = m$ solely location-based knowledge in regard to p_n is taught. In the course of collaborative learning, the curriculum will be incorporated into the knowledge base of the collaborative, the companionship of several individuals or groups of persons, that acquire the curriculum c_n simultaneously however locally separated in the given learning environment. The knowledge base is given by

(5) $K_B = \{k_1, \dots, k_O\},\ O \geq N.$

The knowledge of the collaborative K_B determines the order of visited points of interest p_n. In lieu thereof

(6) $P_v \subseteq P$

is the set of all visited points of interest. The decision basis is a similarity measure, which pair wise defines a value for each location-based curriculum c_{nn} with $p_n \notin P_v$ and the knowledge of the collaborative K_B, i.e. $k_m = c_{mm}$ with $c_{mm} \in P_v$. It is

$$(7)\quad sim: C \times K_B \rightarrow S, (c_{nn}, k_m) \mapsto sim(c_{nn}, k_m)$$

and to each knowledge-tuple (c_{nn}, k_m) a specific value $s_{nm} = [0,1]$ is attributed.

For $s_{nnm} = 1$ the similarity of two given curriculums is at maximum. In succession, based on the computed similarities a new point of interest to visit next is now recommended to the members of the collaborative. In the case of equal similarities with respect to several points of interest, the collaborative visits these points first before new similarities are calculated taking into account the knowledge base K_B. The collaborative learning process is terminated if all points of interest have been visited and no other point of interest exists with $r_{nm} = 1$ for $n \in P_v$ and $m \in P \backslash P_v$.

As an example the scouting program of the North American red-cockaded woodpecker, an endangered species, that is sensitive to minute changes in its natural habitat is given. In numerous studies, the causal relationships of the various environmental factors have been identified, all of which affect the population of the red-cockaded woodpeckers. In the presented system dynamics model the interdependencies of the various environmental factors are shown (see figure 1).

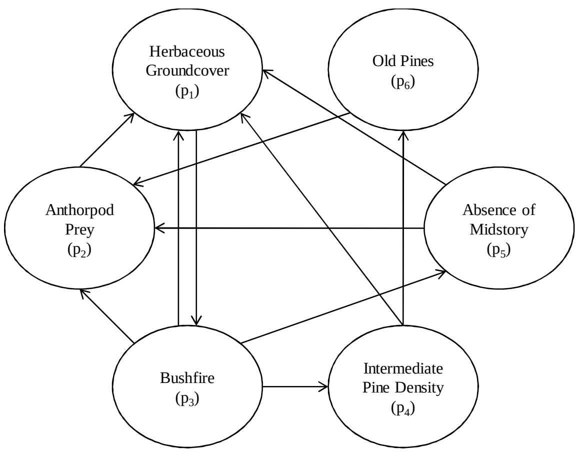

Figure 1: System dynamics model of the red-cockaded woodpecker's habitat (Tucker 2008)

Each arrow indicates an interdependency, for example bushfires promote the growth of herbaceous groundcover. At the same time the density of such shrubs in turn encourages the spread of forest fires, etc.

To learn about this ecosystem and the complex relationships that exist, two touring companies are led by a collaborative learning system through the conservation reservoir.

A collaboration may either be absolutely necessary or advisable for several reasons. Especially in large or distributed learning environments, it is not always possible for a learning individual or group to visit each point of interest. Another reason may be that the socialization of knowledge within the scope of the collaboration is explicitly desired, and helps to ensure that the learning effect is reinforced by such an exchange of knowledge.

Because there is no collective knowledge available yet, each group selects randomly a starting point $p_i \in P$, at which the initial knowledge is gathered. In this case the set of all points of interest corresponds to the respective places where knowledge about herbaceous groundcover (p_1), anthropod prey (p_2), bushfires (p_3), intermediate density pine (p_4), absence of midstory (p_5) and old pines (p_6) can be experienced by the groups. So the impact of a forest fire cannot be observed everywhere in the reservoir with one's own eyes, but only where the fire raged. So group 1 starts at point p_2 and group 2 at p_6. The relevant curriculums c_{22} and c_{66} now make up the initial collective knowledge base K_B. Based on the similarities between the various points of interest and their thematic relation (see Table 1)

	c_1	c_2	c_3	c_4	c_5	c_6
c_1	0.0	0.7	0.8	0.9	0.9	0.0
c_2		0.0	0.9	0.0	0.5	0.8
c_3			0.0	0.8	0.7	0.0
c_4				0.0	0.9	0.0
c_5					0.0	0.0
c_6						0.0

Table 1: Curriculum similarity-matrix

group 1 is now led from the collaborative learning system to p_3, to learn about bushfires (c_{33}) and the impact of such fires on the population of anthropods (c_{23}). The collective knowledge base is then expanded by the appropriate curriculum, and respectively equals $K_B = \{c_{22}, c_{23}, c_{33}, c_{66}\}$.

Now, with $sim(c_{66}, k_1) = sim(c_{44}, k_3) = 0.8$ we experience a special case. The points of interest of both tuples are just as similar. But because group 2 has visited point p_6 already, it now visits p_4. There, the group learns something about the growth of pines (c_{44}) and how the density determines the extent of bushfires (c_{34}). Accordingly, the knowledge base $K_B \cup c_{34} \cup c_{44}$ is extended. The set of visited points of interest is now $P_v = \{p_2, p_3, p_4, p_6\}$. Because of the similarity group 1 now visits p_5 and group 2 visits p_1 afterwards. Thus, for both groups the exploration of the woodpecker's habitat ends and all interdependencies of the different parameters with respect to the population of the red-cockaded woodpecker have been learned by the collaborative based on mobile collaboration and the resulting knowledge socialization.

4. CONCLUSION

The paper showed a new concept to apply collaborative learning in the field of mobile learning. It extends the mobile learning concept with the aspects of aggregated experience by making co-operation an essential part of the mobile learning process. Therefore the time efficiency of learning increases even in a mobile environment as the development of social skills does too.

Regardless to the fact that the presented concept has a high potential to improve the way and the success of learning collaborative groups, it is only a first step in this direction. Aspects like the optimization of the chosen paths to maximize the knowledge a student can learn or the question about the optimal type and amount of information provided at each location is an interesting field of research in the scope of collaborative mobile learning. Therefore it can be summarized that the concept of collaborative mobile learning will be a very interesting field of research during the next years.

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Question and Answer-based Explorative Exercises in a Mobile Game Based Learning Environment

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Abstract

Since many years interactive elements like case studies or business games are an inherent part of university teaching. They are of high practical relevance and convey the problem solving competence of students as well as a structured way of working. But in many cases the problem definition is clear and all relevant information is given to the participants. This situation is not representative for day-to-day business: Many problems are not well structured. Data is missing, the problem definition is not complete etc. This “real life situation” mostly is never been practiced at universities. In this paper we present a mobile game based leaning solution that simulates the real life situation of incomplete problem definitions.

Keywords
m-learning exercises, explorative learning, question-and-answer game, online assessment

1. INTRODUCTION

With the transition from information to knowledge society, knowledge converted into an economic good and got even more important. Its half-life averages but a few years (Munbodh 2008). Constant learning is therefore an indispensable part of our modern life and a key factor of success for the economic development of businesses and their employees. In a traditional manner teaching is, in most cases, knowledge transfer effected by word of mouth. But like other areas of communication, education has been extensively influenced by new information technologies in the recent past. Starting with computer based trainings on CD-ROM 20 years ago, research in m-learning was always oriented in two aspects: a) Using new technologies in order to provide material that is up-to-date in a technical manner. b) Creating m-learning environments that are interesting to learners and really help them to learn and understand the lessons. The first aspect influences the way of learning: At home or everywhere, static or mobile. There occur certain constraints or possibilities depending on the technology used for m-learning. But mostly, the concepts remain the same: Knowledge is presented via video or hypertext. Exercises consist of simple multiple choice, fill-in-the-blank, jumbled-sentences or wrong-false forms. But then, learners don’t really need their knowledge because often they easily can guess the correct answers by systematically reducing the number of possible answers (König 2001). Therefore, the second aspect deals with the concepts of providing information to learners: How could content be brought to learners in an interesting and didactically good way so that students or pupils don’t get bored and really learn new and relevant things? Since many years, so-called intelligent tutoring tools are in the focus of research (Brusilovsky 1992, Patel & Kinshuk 1996, Siepermann 2005; Siepermann & Lackes 2007). These tools are created in order to provide sophisticated m-learning exercises that do not contain the solution of an exercise in a more or less apparent form. This is a prerequisite for effective learning and understanding because then learners have to find the answer on their own by using the learned approaches and their own knowledge instead of guessing the correct solution (König 2001). Unfortunately, even if those interactive and sophisticated exercises are highly recommended (Haack 2002) they either do not exist or are very seldom in e- resp. m-learning because of their complexity (Siepermann 2005). Thus, a suitable m-learning environment should focus on both aspects: In order to achieve a self steered learning that is one of the most efficient ways of learning (Kerres & Jechle 2002) it should be based on the newest technological trends like the WWW and mobile devices. Its interactivity and multi-mediality are an inherent part and offer various possibilities for m-learning exercises and tools. Therefore, m-learning tools get more interesting. As a side effect, the WWW allows students to practice whenever and wherever they want to. In addition, e-/m-learning systems should give feedback in a predictable time. (Bolliger & Martindale 2004) Otherwise, if the delay between answer or mistake and feedback is to long the learning process stagnates. Beside the technical requirements, m-learning systems should be sophisticated and more complex than the simple forms mentioned above. (Haack 2002; Weidenmann 2002)

Otherwise, a learning progress can hardly be observed and measured.

2. GAMES AS A NATURAL WAY OF LEARNING

Within the past decade, the concept of game based learning (GBL) got into the focus of research. GBL is an old concept that is based on the observation that playful learning is more effective than the classical teacher to pupil role allocation. The reasons for this are obvious (Schwill 2008): People prefer doing something for fun that resembles to some kind of amusement or hobby. People prefer doing things voluntarily instead of being forced to. Just doing something (exploration and experimentation) helps people to understand how things work. But often, the game is only used as a straw man: The main motivation is that pupils or students can hardly be motivated to learn. They are not capable to concentrate anymore and need a continuous stimulation for learning. Then, GBL shall motivate the learner to occupy himself with a certain topic (Pivec et al. 2004). The game itself is only used as a medium to transport knowledge to the gamer. It is a straw man who has to be interesting and "cool" enough so that learners are willing to play the game and to learn. Often, game and lessons have nothing in common. On the one hand there is the game on the other hand it can only be played if the learner acquires some knowledge that has not necessarily interrelations to the game. Or the knowledge is given as a reward when solving a part of a game. Reducing GBL to some kind of motivation neglects its real potential. A well and well known known example for good GBL is the management simulation TOPSIM. It is a turn-based game where several groups of learners play against each other. In each round they have to do some decision making. Then, depending on the decisions the simulation starts and computes the next situation. In this game learners learn how enterprises work and which interrelations between own decisions, markets and competitors etc. exist. If a decision was not considered well enough the learner has to face the consequences in the next round. He would hardly make the same mistake twice because every group wants to win the game i.e. wants to be the best group with the highest profit. Even if there are many calculations in each round the turn-based concept reduces the requirements concerning the computational power. That is the reason why TOPSIM can be played for many years when the computer technology was not that powerful that it is today. Now, instead of being taught, learners can now learn on their own by observing, experimenting, making mistakes and succeeding in real time.

3. PROBLEMS OF GAME BASED LEARNING

As we can see there is a wide range of possibilities creating m-learning systems and especially GBL systems but some disadvantages of those GBL systems are obvious. First of all, the application area often is very restricted and special. The game is for a very special purpose and cannot be adapted easily to other areas. For each topic a new game or "level" has to be created. The game itself cannot be configured by exchanging only the knowledge data that should be learned. Mostly, the game has to be changed itself. That leads to a high work load when creating games. Because the games are quite special, in many cases they just cover a small application area. Thus, it is doubtful if it is worth to use a game for a small application field when it has to be installed, configured, explained to learners etc. A more hidden disadvantage concerns the concept of games: In most cases the problem that is to be solved is clear. The learner knows at once what kind of job he has to do. But this situation is not representative for day-to-day business. Many problems are not well structured. Often, the problem definition is not specified exactly. An employee does not know exactly what he has to do. Therefore, he has to do some investigations or to make some assumptions before he can do his job. Without training it is difficult to make the right assumptions and to find the correct specification of a task.

4. LEARNING CONCEPT

In business studies it is important to learn how to act in uncertain situations where the level of information is incomplete. That means we are facing the situation that there are several possibilities of action, certain restrictions and incertitude about data. Thus, the problem is not well structured. This situation also appears in business games. But in business games, mostly there is a certain question that has to be answered. For example: "Which investment of given alternatives should be done?" We would like to construct a situation where there are two possibilities: a) The objective is not precisely given. It has to be specified by the learner when playing the game. b) The objective is given, but the situation is imprecisely defined. The situation (i.e. data/information) has to be defined in order to obtain the correct solution for the given problem. Therefore, the learning situation will be as follows: For the learner, each exercise consists of a textual description. This description comprises a characterization of the situation and the problem the learners are facing. The description of the situation as well as of the problem can be incomplete and imprecise. Thus, the learner firstly has to understand the exercise. This can be the first part of the exercise that cannot be solved without further information. Therefore, the learner can ask the system some questions about the situation and the problem. Then, he has to structure the situation and the problem. He has to discover what he has to do in the situation and then how he has to act. If he knows this, he has to collect the information he needs to solve the problem. In each stage of problem solving the learner can ask the system questions about probably missing information. In the final step, the learner has to give the answer concerning the problem. The form of this step depends on which situation if the objective is precisely given or not (see above situation a or b). If we are facing situation a then only one result can be demanded because otherwise it is difficult to distinguish the several values. If we are facing situation b then several result fields with captions can be provided.

5. LOCATION BASED EXERCISES

So far, the presented concept can be applied to e-learning-systems as well as for m-learning systems but with increasing use of mobile technologies in past years m-learning has gained importance as an e-learning domain and will probably gain even more in the forthcoming years. However from our perspective, the core of the matter is not entirely conceived yet because m-learning should not be based on the mere extended spectrum of portability of e-learning concepts. E-learning in general is characterized as location independent, yet only m-learning as a special form enables people to acquire knowledge anywhere and at any time. However it is subject to the precondition that the learning process can be halted and resumed regardless of the location without any problems. Yet m-learning exceeds porting of existing e-learning solutions with regard to technical specifications of mobile devices. Suppose that a learning process is initiated at location A and continues at location B. In use of non-mobile technology it is referred to as classic e-learning without consideration, yet we often mistake such a succession as m-learning if mobile IT is deployed. Likewise the distance between A and B is of no relevance. For classification just a change of location seems appropriate i.e. the learning process will continue without any adjournment. Hence m-learning has to be considered literally as e-learning on the go.

Paper chases are well known location based games for a long time, even if they are usually not named like that. The principle is pretty simple: A group of people hides at a secret place and a group of chaser has to find them. To make this a solvable task the hiding group lays a trail where arrows on the floor, little riddles and exercises give hints for the hideaway. Of course there are false trails too, but those can be exposed by try and error or by solving the mentioned riddles. The main disadvantage of this game is the fact that the hiding group has to clearly define the riddles and the information breadcrumbs they leave behind. In other words they cannot adjust the difficulty regarding to the speed and success of their chasers. This is especially a problem if the riddles are too hard and the chasers stuck at a certain point of the trail because no more helping hints can be added afterwards. Those situations have a negative influence to the motivation of the chasing group and in the worst case it ends up with the surrendering of the chasers.

From this point of view paper chases are some kind of a not-well-structured problem. The aim is well defined but the way to the solution is characterized by false trails and sometimes unclear or even missing information. Therefore some investigations have to be done or assumptions have to be made before the task can be solved.

Combining the former described exercise concept with location based games we receive what we call Mobile Question-and-Answer Based Explorative Exercises. An example of application may be a city tour, which is more or less the same scenario as a museum tour but on a much larger area and which is truly depending on the learner’s location.

6. SYSTEM ARCHITECTURE

The architecture for a GBL-system which fulfils the former described requirements has to handle with several issues. These issues are the result of dealing with natural language and the requirement to provide some kind of tutoring system which can give hints and feedback to the learner. Of course there are former approaches for artificial communication like the well known ELIZA system which already influenced computer games or (to some degree) today's chat-bots. The main difference between these systems and an artificial intelligence for a game based learning-system is, that the main objective of those approaches is to make the human user believe he is talking to another person and not with a machine. This fact simplifies and complicates the usage in the context of game based learning at the same time. On the one hand the system has not to convince the learner about its “humanity”, so answers may be recognized as artificial. On the other hand the system always has to answer in a valuable manner. That means that a question cannot be answered with unspecific counter questions or universally valid statements. Therefore the questions have to be analyzed in a more complex way than other systems do. First of all the system has to distinguish different types of questions in order to be able to provide just as much information as asked for. After that the semantic of a question has to be recognized which is certainly the main issue to solve. Despite enormous progress in computer technology and research in the last years a real “understanding” cannot be done by computer systems today. But the questions can be searched for predefined keywords. These keywords can be expanded by the use of ontologies and dictionaries for synonyms and homonyms. Furthermore the paths in an underlying ontology can be used to calculate semantic distances between two terms, where one of these terms is the used term in the question of the learner and the other term belongs to an relevant information which is missing in the exercise description. With respect to this distance the system can generate hints for the learner to lead him to the right direction, where this “right” direction has not to be the most similar information the system has to provide as will be explained later. On the other hand off-topic questions can be recognized, so the system can tell the learner that his question seems to have nothing to do with the exercise. In this case the type of answer might differ in the range from clarifying to obfuscating, regarding to a preset difficulty level. Because this question-answer driven game is nested in an educational context the system has to lead the learner through the exercise with respect to didactical structures. That may include a particular order with which information have to be revealed. In the end all questions and provided information have to be logged. This logging can be compared with the student's solution to give him a feedback about his failures, efficiency, improvable points and statistics which will enhance the learning experience and success. Other issues are linked to the usage of mobile devices. Regardless of the technical improvements mobile devices made during the recent years they do not touch the capabilities of desktop-PCs. This includes the disc space as well as the computing power. Because we have to handle with huge amount of data because of synonym dictionaries, ontologies etc. and the resource-intensive calculation of the meaning of a question and its answer we have to fall back on a client-server architecture where the server processes the questions of the students and sends them the answer to their questions taking (for example) their actual position, their former asked questions into account. The main advantage of such a client-server architecture is that the calculation of a sufficient answer can always be improved without being notified by the students because they do not need to update their mobile application. The main disadvantage of this system is, that the student has to be online for every question which presumes that the network coverage is given on the whole paper chase trail. But these problems will vanish because of mobile flat rates and high investments of the mobile network operators. Therefore those mobile question-answer based explorative exercises will make a great improvement to actual e-learning exercises.

7. CONCLUSION

This paper showed a general concept for question-and-answer based explorative m-learning exercises. It was shown that this type of exercises can exploit new application areas of game based learning systems. Several issues have to be solved regarding to the processing of natural language when implementing such a system. The development can draw on existing systems for natural language processing but has to redevelop the operating principles in order to provide valuable answers all the time. Nevertheless it can be summarized that the learning experience and success can be improved through the possibility of individual support by hints and evaluations. In a second step this individual support can be improved by a linkage to an automatic marking system for the resulting learner's solution (see Siepermann 2005). Therefore it can be stated that this field of research has high potentials to improve the learning process and it is worth to put further efforts into it.

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Virtual Mobile City Guide

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Abstract

The Virtual Mobile City Guide (VMCG) is a mobile application which aims to provide the user with digital equivalent tools which tourists normally use while travelling and provides them with factual information about the city. Using Android technology, the VMCG is a mash up of different APIs which together with an information infrastructure provides the user with information about different attractions and guidance around the city in question. While providing the user with the traditional map view by making use of the Google maps API, the VMCG also employs the Wikitude® API to provide the user with an innovative approach to navigating through cities. This view uses augmented reality to indicate the location of attractions and displays information in the same augmented reality. The VMCG also has a built in recommendation engine which suggests attractions to the user depending on the attractions which the user is visiting during the tour and tailor information in order to cater for a learning experience while the user travels around the city in question.

Keywords

Mobile Technology, Tourism, Android, Location Based Service, Augmented Reality

1. INTRODUCTION

A person visiting a city might at different stages of his/her trip require different forms of guidance and assistance, whether or not the city is known to the person. The 'tools' which people normally use while navigating in a city are maps and guidebooks which are generally utilised in printed form. Another item attributed to tourists is the camera which people use to try to save the moment and share it later with their friends or relatives back home. Tourists or visitors of cities usually also ask other fellow perambulators about different attractions or places of interest or perhaps suggestions about which attraction is in reality nicer or more recommended to visit.

The Virtual Mobile City Guide (VMCG) is a mobile application which tries to bring all the above mentioned means of assistance in one place. The problems which tourists find were investigated using secondary research and this was also followed by an investigation of the way tourists use mobile devices to assist them in navigating a city. These problems and respective solutions will be carefully examined, studied and eventually employed in the system.

Using Android technology, the VMCG is a mash up of different APIs which together with an information infrastructure provides the user with information about different attractions and guidance around the said attractions. While providing the user with the traditional 'Map View' by making use of the Google maps API, the VMCG also employs the Wikitude® API to provide the user with an innovative approach to navigating through cities. This view uses augmented reality to indicate the location of attractions and displays information in the same augmented reality.

From an administrative point of view, the VMCG allows various cities to adopt the same framework but providing the application with a different profile of the city in question. This would allow the users to use the same interface while having information relevant to the city they are visiting at that point in time.

The VMCG also offers the capability of suggesting different attractions depending on the likings of the user. For the sake of practicality, the VMCG also allows the user to use the mobile device as a camera and organise the photographs taken while using the application in a dedicated directory.

2. TOURISM BACKGROUND

Brown and Chalmers (13) identified the following problems which tourists face while on holiday. The first problem was the "*What to do" problem*. Brown and Chalmers explain that unlike work, there is not a particular or strict goal which must be reached by the end of the holiday. The tourists face an "open-ended" list of options since tourism entails a choice from various activities such as commercial activities, social activities and so on. The *"how" problem* outlines the situation in which tourists may find themselves and eventually being exploited. Brown and Chalmers say that an issue in this case is the cultural norms possible minor clashes when the difference of the culture of the tourist and that of the place being visited clash. The tourist needs to be equipped with knowledge about how to get something from place which is being visited to avoid exploitation. (13). The *"Where" problem* is about finding where things are. There are different attractions which tourists can visit and they are also restricted with the time at hand to go around the attractions. Brown and Chalmers emphasise that tourists "need to avoid spending too much time travelling between places" (13).

Guidebooks and Maps: The guidebook is one of the tools in the hands of tourists. In their study, Brown and Chalmers explored the advantages of paper publications and they claim that it is important to know since it helps when creating the digital equivalent. Guidebooks also include recommendations for tourists and thus help tourists reducing their uncertainty (13). Guidebooks nonetheless sometimes provide limited information when describing how to find a location of interest since it might not always be clear or tourist might confuse what they are seeing with what is written on the guide book. Brown and Chalmers claim that maps are the second popular tourist publication after the guidebook since in their study numerous tourists were observed making use of a map. Nonetheless, when using a printed map, tourists might not be essentially going in the correct direction. Brown and Chalmers say that a second feature of a map is the "combination with guidebooks".

Pre- and Post-visiting: Brown and Chalmers proposed the last solution to be pre-visiting and post-visiting places in order to manage their holiday. Pre-visiting is about planning the holiday before or while being at the destination. Post-visiting is about extending the enjoyment of the holiday personally or with others once the holiday is over. Brown and Chalmers stress that the combination of "talk and interaction" helps tourist do the most of their holiday in both activities (13). One does a pre-visit of a place whenever he/she looks for information about the destination before actually going there, thus planning beforehand. Post-visiting is about "reminiscing and sharing" the experience which the tourist had during his holiday (13). The tourist would organise the photographs or media gathered during his holiday and share the experience with other people who may or may have not been at the holiday.

The following existing systems were explored prior to designing the VMCG. These were namely the CRUMPET application (4), the GUIDE application which was implemented in Lancaster (14) and the Italian case study of a system implemented at Locri (15). These will help us understand various issues tackled in previous parts of this review and observe how touristic problems were tackled and solved.

3. TECHNICAL BACKGROUND

In this study, localisation and augmented reality were investigated. A method had to be devised to know where the tourist is at a current point in time and where are the locations which he/she would be interested in visiting. Augmented reality was used to display the information to aide orientation of the user. Below follows brief exploration of these two topics.

3.1 Localisation

Localisation is about navigating a particular place with knowledge about the current location (1). Virrantaus *et al* also go into further depth and precision in defining the concept of a location based service as having the "ability to dynamically determine and transmit the location of persons...by the means of their terminal" (2). Steiniger *et al* also define localisation as the process of having the mobile device exploiting its position in order to provide the user with information (3).

Steiniger *et al* explore the relation of Geographic Information Systems (GIS) and the concept of a localised service or location-based service (3). Their philosophy is based on the principle of Virrantaus *et al*. It is further extended by asking short questions which clearly define the concept (3): "where am I?" "What is nearby?" and "How can I go to?". Schmidt-Belz *et al* express it in a lower level of abstraction and put these questions into the context of a tourist on a tour. (4) Steiniger *et al* list the components which make up a location based service (3). These are the mobile device itself, the communication network, the position component which in this case is the GPS, the service and application provider and the data and content provider.

Another approach in localisation is that of recognising the environment and building. Moreover, there exist different techniques which are employed to extract features which would assist in recognising buildings. Bres and Tellez (5) based their work on SIFT technique (6). Chung *et al* explore sketch-based representation and spectral graph matching (7).

The technique dealing with building recognition involves an intense computational effort in order to cater for the difficulties described by Bres and Tellez and mitigate them accordingly. On the other hand, the technique which employs geographic information is a lighter approach for localisation. When compared to the former technique, the disadvantage of this method is that it requires a continuous visibility so that the device can be tracked by satellites so that the device receives the respective GPS coordinates.

3.2 Augmented Reality

In each survey of augmented reality, Azuma (8) always presented and quoted the wider the picture of the *reality-virtuality continuum* which was originally presented by Milgram *et al* in 1994 (9). Augmented reality is the addition of virtual elements to the real world and is a variation of Virtual Environments (10) in the sense that unlike virtual reality the user can still see elements of the real world while using an AR system. In his survey of augmented reality (10), Ronald Azuma summarised from his findings that the characteristics of an augmented reality system are the combination of real and virtual worlds, interaction within the environments in real time and a 3-dimensional representation of both environments for the alignment of real and virtual objects.

The VMCG uses a video-based and such a display would provide the user with a "*window on the world*" and thus the user will not be totally immersed since one is not necessarily in the real place were the events are situated (9). Piekarski refers to this technique as "*video combined displays*" (11). In practice, this technique uses cameras which feed the real image in the computer simultaneously with the graphical image to be imposed (11).

In their 2001 survey, Azuma *et al* describe this class as a "*flat panel LCD that uses an unattached camera to provide video see-through-based augmentations*" and also serve as a "*window which shows the real object with an AR overlay*" (8). In 2009, Nokia claimed that they are engaged in numerous research projects in the field of mixed reality where they also said that mobile phones "*can be used to connect the physical world with the vast amounts of online information"* (12).

4. IMPLEMENTATION

The VMCG was implemented as an application on the Android platform. The Android environment was mainly chosen due to the following reasons entailed below. Burnette (16) claims that Android is special when compared with other platforms since it is truly open source and a free development platform. Android applications component-based architecture inspired by internet mash-ups and also enables built-in services e.g. GPS, Accelerometer, SQLite, Camera, Compass (Google, 2010). The automatic management of application life cycle and High Quality Graphics and Sound Supports MPEG4, MP3, AAC, AMR, JPG, PNG, GIF H.264 (Google, 2010). Above all, Android applications are nowadays more portable across different devices (16).

The VMCG was organised in a shallow user interface so that the user will be able to easily use the application. Figure 2 shows the main menu of this application and shows the main menu which provides the user with the basic features of the application which aim to solve the tourist problems described by Brown and Chalmers.

One of the main features is the listing of attractions. Once this option is tapped, the events are presented as a list. When an event is selected, a new screen would display all the information about that particular event and is also offering an option to show the event on a map.

The nature of the tour together with the content and list of attractions can be controlled from the web source and through the <city>.xml initialisation document. The information can be therefore modified to provide a context for the user in order to experience a particular aspect of the city. Furthermore would learn about the topic or context by being physically in the places in question while, being provided with background information as shown in figure 3.

Another feature is the map view which is a module that provides the user with a map interface to assist them while navigating in a city. This module makes use of the Google Maps API which is conveniently used in the Android platform since both technologies form part of the Google family.

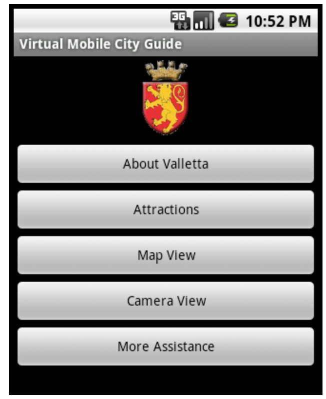

Figure 1: VMCG Main Activity (Source: Dylan Seychell)

The Camera View feature was included in this project to assist the user when looking for a particular event. This module provides the user with augmented reality to locate events while looking around through the mobile device. The Wikitude® API[1] was used to develop this module and the result is shown in Figure 3. Figure 3 shows the application being used in front of the Grandmasters' Palace in Valletta and a tag is displayed on the building while an information box appears on the screen which could possibly house information about the building in question.

Figure 2: Photograph of the VMCG in Camera View using the Wikitude® API (Source: Dylan Seychell)

The other features of the VMCG are made available by employing an Android activity menu in the main activity described above.

The VMCG is also capable of providing the user with suggestions. The recommendation algorithm which runs while the application is being used revolves around the 'event' object and uses its attributes to rank a respective event in a given list of events. The system has to fairly rank events so that the final list would reflect the user model as possible. Below follows the algorithm:

1. **FOR ALL** events
    - 1.1. **PROCESS** average waiting time
    - 1.2. **GET** current score of event

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[1] http://www.wikitude.org/

1.3. **IF** average time is equal to 0 **THEN** set average time to 0.00001
1.4. **IF** the event is **NOT** visited **THEN**
  1.4.1. **STORE** current event rating
  1.4.2. **GET** weight of category
  1.4.3. **PROCESS** time score: $\left(\frac{Current\ Waiting\ time+1}{Average\ Waiting\ time}\right)^{-1}$
  1.4.4. $temp\ Score = (category\ Weight + event\ rating + time\ Score)$
  1.4.5. **UPDATE** score of event
1.5. **END IF**
2. **END FOR**

The suggestions feature assists the user while tackling the "*what to do*" problem. While providing the tourists with suggestions, this feature can be also used to present buildings and attractions which fall in a particular category, say historical era. A training option is also offered to allow the user fine tune the user model guiding the suggestions. This feature ensures the relevance of the recommendations and would then encourage the users to use recommendations features of the VMCG.

The VMCG also enables the user to use the camera of the mobile device and take photographs while using the application. This helps the tourists during the post-visit phase of the trip.

5. EVALUATION

The system was evaluated using the marketing research process as described by Kotler *et al* (17). In depth interviews were conducted with specially selected stakeholders dealing mostly with open-ended questions. Short interviews were also conducted with random respondents in the city of Valletta. In the latter part of the research, the personal, touristic and technical profiles of the forty-two respondents were investigated. Subsequently, a demonstration of the VMCG was given and questions were asked about the application.

The age of the respondents had a range of 49 and they constituted of 12 different nationalities. We did make an effort to ensure that although Maltese respondents were an important contribution to this evaluation, the proportion would be fair when compared to other possible contributions.

The majority of the respondents found the VMCG easy to use and they also answered that the tools provided by the VMCG were enough for a tourist to travel on his/her own in a city like Valletta. When investigating the statistics focusing on the acceptance one could easily see that the respondents who are used to installing applications on their mobile device are those who would not hesitate to install the VMCG on their phone. When this was analysed in detail it resulted that all the owners of phones with either the Android or iPhone platform answered that they would install the application. Respondents also expressed their interest in following the recommendations presented to them by the mobile application and said that they would trust these suggestions.

The evaluation also showed trends which indicate that owners of PDAs and Smart phones are more willing to install such applications when compared to the owners of simple phones. Nonetheless, the problem of acceptance of the VMCG application was the hardware requirements of the said application since from this research it resulted that only 10% of the respondents had a device which had all the hardware requirements needed to run the VMCG.

6. CONCLUSION

The concept of having a mash-up application designed to assist tourists during their visit was welcomed by many during the evaluation and promises positive prospects. It was also shown that the Android platform provides the adequate environment to develop such applications.

The graphical user interface (GUI) was given special attention in the design of the VMCG but more diverse user interaction methods such as audio should be sought. The GUI should also be developed to cater for directions and improve accessibility by allowing varying text size among other possible adjustments. A suggestion which also emerged from the evaluation was the possibility of having the VMCG in different languages. In the effort to also meet the solutions proposed by Brown and Chalmers, the collaborative aspect of the VMCG has to be developed by possibly allowing connection to social networking sites. The evaluation also showed the lack of willingness of users to update the information in the application while they travel. This can be overcome by designing business models which enable incentives to the user. The guidebook aspect of the VMCG should also be developed by providing more in-depth information and also illustrating possible transport connections to other cities in proximity to the city being visited.

In this paper we also presented how to apply different technological developments in the field of tourism in order to address the needs in the latter field. The views presented in the VMCG were satisfactorily welcomed by the potential users. It was concluded that the GUI considerations are important for the users of the system and more effort should be invested in order to allow different and rich ways in which the users can interact with the system. The development of this application in the context of a framework which caters for both pre-visiting and post-visiting is our next challenge.

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Mobile Interactive City Adventure - MICA

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Abstract

Game based learning is a highly-researched phenomenon which is being adopted by a lot of institutes to motivate students in their education experience. MICA was developed as a "proof of concept" that by blending the use of different mobile technologies and the concept of adventure based learning together with a mixture of AI and education; one can create an interactive and interesting environment for students. By allowing the user to gradually accomplish small tasks until finally reaching the end goal, MICA encourages the user to gather information him/herself.

Keywords

Games, Mobile Technology, Adventure-based learning, Digital Natives, Education

1. INTRODUCTION

Games are perceived differently by different people. While parents may see games as a waste of time, children perceive them as a leisure activity which they can enjoy doing. Recent studies show that games can increase the learning rate of participants when used in educational scenarios. Games have already been used and were quite successful in business training, military, surgical and medical amongst other applications. Game-based education is used to support specified training needs by practicing scenarios and particular skills (Freitas).

Our main objective is to create a game-based learning application which will be able to assist the user in learning the cultural background of one of the richest historical cities of Malta, Valletta. We further on found the need to extend our main objective, and make MICA a framework which could easily be modified to support other city games from all over the world.

This paper will gives a brief overview of the research done in order to understand better the modern notions of augmented reality and game based learning. This is followed by a brief description and justification of the technologies used and an explanation of the design and methodologies. This leads to the final section of the paper which describes the tests performed and corresponding results. Finally, the conclusions section consist of a brief discussion stating the strengths and weaknesses our application.

2. BACKGROUND AND MOTIVATION

Game developers are nowadays motivated to introduce educational games in educational methods helping to transmit information in different and more effective ways. Mobile technology is a modern tool available to educators to transfer knowledge to their students, especially 'Digital Natives', in innovative ways. In our study, we found that introducing a game with an adventure-based learning environment helps motivating the students to participate and retrieve information on cultural and historical aspects on their own.

Apart from the game background and foundations of MICA, another important aspect is the use of Augmented Reality in order to make the game more realistic and immersive to the user. Augmented Reality mixes the actual environment (perceived through the mobile's camera in our case) with virtual objects on the same display. (Milgram, Takemura, Utsumi, & Kishino, 1995).

2.1 Augmented Reality

Augmented Reality (AR) has been around for a long time. Back in the 70's, we could already see some kind of Augmented Reality implemented in the making of movies, where art painted scenes overlaid the actual scene to add to it what was needed. (Arthur) Augmented Reality should not be mistaken with Virtual Reality, even though they are very much related. Virtual Reality as its name suggests, creates a whole new virtual environment for its user. That is, the user is not able to see the real world environment as this is replaced by the virtual one. Augmented reality on the other hand keeps the real world environment visible to the user but overlays virtual objects on it. This overlaying is done in such a way that the virtual objects and the real world environment seem to be on the same space. (Azuma, A Survey of Augmented Reality, 1997) These virtual objects may vary from just plain text, to 2D pictures and 3D models. Plain text can be used to give information to a user about the current world environment being used. For example plain text can be used to guide a worker through his work at a word site. 2D pictures can be used together with plain text to make the view more interactive and eye pleasing. On the other hand 3D virtual objects can be overlaid on the real world environment to show users how these 3D object may look in the environment. This aspect is an asset to online shopping, where for example a customer buying a sofa can see how the actual sofa will look in the living room (Azuma, A Survey of Augmented Reality, 1997). With all this information in hand we decided that implementing Augmented Reality into our application would make the game much more interactive. The Wikitude API enabled us to overlay 2D pictures and plain text on the view that the user sees through the mobile's camera.

2.2 Mobile Based Learning

Games can be grouped into *leisure games*; games with no educative purpose which are used just for fun, and *serious games*; which are intentionally meant to be more educative or have a special purpose for example army training, business training or educative for all ages.

New education methods are being explored in order to offer effective education to 'Digital Natives'. Digital Natives are the younger generations of people that have been exposed to an environment full of digital technologies since birth. Schadenbauer (Schadenbauer, 2009), claims that traditional educational methods are not effective for such people, since they have little patience to learning without digital technologies. In his review, Eck (Eck, Digital Game Based Learning, 2006) argues that digital natives "require multiple streams of information, prefer inductive reasoning, want frequent and quick interactions with content, and have exceptional visual literacy skills" and that these are all characteristics that can be satisfied by Digital game based learning.

Mobile technologies nowadays include locations services such as GPS, camera, reasonable computing power and memory, compass and accelerometer. Mobile applications like those discussed in (Schadenbauer, 2009) and (Cutri, Naccarato, & Pantano, 2008) try to exploit this power to make the application more interactive, more user responsive and interesting which thus satisfies the need for serious games for digital natives. The navigation system available on the mobile enables the application to provide information to the user depending on his location and thus, information is given gradually to the user which makes it easier to remember and more interesting for users.

2.3 Educational Game Motivation

Malone (Malone, 1980) establishes a number of heuristics that help to guide an educational game to be more entertaining and fun for its user and thus keeping the user motivated throughout the game. He states that the characteristics that make the game enjoyable can be grouped into 3 categories: *challenge*, *fantasy* and *curiosity*.

Challenge: A game must provide clear and well defined aims of what the user must achieve which should be combined with good feedback on the overall game progress. An overall score can help achieve the feedback on the actual game progress, where an increase in score denotes more knowledge acquired by user.

Fantasy: The setting must be interesting and interactive to the user and relevant to the game for example, using terminology of the Knights Era.

Curiosity: The game environment must have a level of complexity that is more complex than the actual knowledge of the user in order to make users feel that their "existing knowledge seems incomplete, [or] inconsistent" which thus makes the game feel useful for its user, as Malone states. If this occurs, the user will be learning through the adventure of the game and thus deeper learning occurs (Preston & Morrison, 2009).

3. TECHNOLOGIES USED

The main objective of this application was providing an adequate framework for learning within an entertaining scenario. A game that enhances the learning process is the treasure hunt which motivates the users in gathering information and answering question related to that information in order to level up in the game. A similar concept of treasure hunt was outlined by (Erica) who used a treasure hunt-like game to motivate students learn English. She varied the activities and information used to encourage her students learns in such environment.

3.1 GPS and Google Maps

By using Google Maps we are able provide the users with a map of the location they are playing in. Even though a map is helpful, we thought that it would be much better if the user can see his/her exact location on the mentioned map. With this in mind, we used Global Positioning System which is a free service that allows its users to get their exact location. By combining Google Maps and GPS we were able to show the user his position on the map.

3.2 Mobile Accelerometers

A virtual compass was created and laid upon the map, to define the orientation of the mobile device and the user, thus giving the user a sense of direction. This compass is implemented through the use of accelerometers and gravity field sensors (Meier).

3.3 Wireless Networking

Internet access is required in order to access Google maps, retrieve data from the remote database, and update data found within the same database. In order to provide such service to the users, we decided to use Wi-Fi (Brain & Tracy, How WiFi Works, 2001) which gives the great advantage of mobility. Wireless networking, also known as Wi-Fi and 802.11 networking allows users to access the internet without the use of wires. Such technology uses radio waves to perform communication just like radio and mobile phones. When data is sent, a wireless adapter converts the data into radio signals and transmits it using an antenna. Afterwards, this signal is received by a wireless router that decodes it back to its original data.

3.4 Android Mobile Platform

All afore mentioned technologies are incorporated and used on the Android platform. In their paper (Spectrum, 2008), Spectrum noted that this mobile platform is built upon the Linux Operating System and can be used on any mobile device that makes use of Android application stack. This stack is also known as the Dalvik virtual machine and is split up into a number of layers.

The base layer is the Linux Kernel which provides the basic functionality for the kernel. This kernel defines the drivers that can be used on such platform such as the USB/Keypad and other drivers. This layer acts as an abstraction layer between the hardware and the Android Operating System. Programs do not call Linux directly but Android uses Linux for its internal management of resources and services. It uses Linux because first of all it is already open source and has great memory and process management.

The other layer is the Application Framework which allows developers creating their own applications to have full access to the same framework used by the core applications. The Application layer is the only layer which the end user will see. Android applications are increasing rapidly by time.

4. DESIGN AND METHODOLOGY

This system's design was split into multiple modules were each had a particular function to perform. The system was designed to be as modular as possible, in order to keep it as a framework by separating the data and how it is accessed from the logic of the game. Also, the modular design allows the possibility to change or add a challenge game without affecting the other modules. The database guides the flow of the application and the internet module translates data retrieved from the database to the format used in the application, mainly XML files.

During the game play experience, the user will be interacting with various different user interfaces, each of which has got their own functionality and operations. At a particular point the user may be using the map to get to a landmark, reviewing gathered facts to get the answer of a clue or playing a game to advance to the next hint. All of these instances have got their own interface which is specified in the general module. Hence, we decided to put all the interfaces' handlers that are used to populate and use these interfaces in one module, called the User Interface Module.

The system was designed to be as expandable and maintainable as possible. Hence, we decided to implement a dynamic database which is located on a remote host. It is much easier to update data found within a central database then data found on a number of mobile devices. Having all the data on a remote database, an Internet module was developed to provide the functionality to connect to the host database and retrieve information from it. Connection is done via ASPX pages where the request is carried out using an HTTP get request and the ASPX pages generates the required XML on the web server and sends them back. This module will then receive the XML file containing the results found and will forward this file to the data module.

All the data received is in the form of an XML file. However, all data usage is handled within the Data Module which is responsible for the processing of information. In this module the business objects fact, clue and user are defined. This module also contains the sax parsers required to extract data from the XML files. When accessing data from the internet module, which in turns request data from a host database, this returns an XML file containing the relevant data. This XML file is parsed and the relevant information is extracted. The parsers found within this module are the facts parser, clues parser, user parser, quiz parser and landmark parser. The Data Module Interface defines the methods which can be found in the Data Module Implementation where the latter contains code to add and retrieve data.

The challenge games module defines the mini games that can be played when a user completes a clue and prior to getting another hint. These mini games include a Quiz, an Image Puzzle slider and a memory game, all of which have dynamic content. These mini games are the milestones of the overall treasure hunt.

The camera view module implements the augmented reality of the game. With the help of Wikitude this module gives us the ability to overlay a variety of virtual objects over the real world environment. When a user switches to camera view he is able to see the real word environment, together with overlayed 2D pictures that represent facts in the area, and plain text that explains each fact.

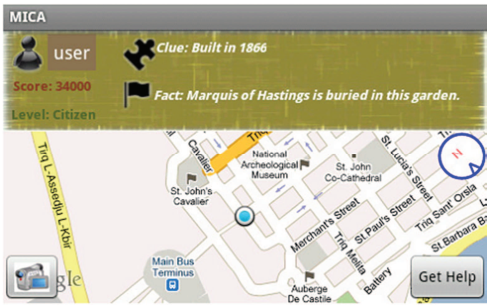

Figure 1: The main user interface of the game

4.1 Dynamic Aspect

When the game starts, a connection is made to the database server and the user's information entered within the login form is passed to it. A loop is initialized and will keep updating the user location on the database every time quantum. During the game a user may either solve a clue or gather a fact. If the user gathers a fact, this fact will be added to the list of facts he knows and inform the database about his success so that his score may be incremented. If the user solves a clue, then a mini game, which can be a Quiz, a Memory game or a Picture puzzle slider is prompted and the user will have to win the game to be able to get the next clue. When the user successfully wins the game, the score on the database is incremented accordingly. If the user manages to reach the maximum level then the game ends, otherwise the user will be prompted with the next clue where the game loop starts all over again.

5. TESTING AND RESULTS

Since an incremental development approach was used, testing had to be split in stages; each stage represents an activity. Each activity has its respective modules where each module has to be tested on its own. Modules were incrementally implemented to the system and then each module had its integration systems with the entire system (Modular Approach). Testing was carried out both on the Android emulator and on the mobile device sponsored by Vodafone Malta using mock data. Several test cases were carried out to test and verify that the main functionality of the system as designed and specified.

6. FUTURE WORKS

A useful feature that would enhance the learning experience would be to create a synchronization system that initiates when the user gets near a landmark. Specific places will have a special server from which data such as virtual tours or promotional content can be downloaded. When the user gets close to these places, the application can be extended to ask the user whether he wants further information about this place. If the user accepts a message is send via Bluetooth to these servers and request data from them.

The game play experience can also be enhanced by incorporating a multiplayer feature to our system which may take various forms. One way of providing users interaction is to provide a system in which a user can leave hints to other users on the Wikitude activity. At any point within Valletta, a user may be offered the facility of leaving a hint that other players may see. It is important to note that this will have to depend purely on the users' maturity to leave fruitful messages for other players.

7. CONCLUSION

In this paper we have presented our mobile application which enhances game based learning in the context of historical events that occurred in the city of Valletta, Malta. We started by giving an overview of our research in the literature reviews section, we described the technologies used, this application's design and methodologies used within our application. The last section of this paper contained the testing performed on our application, the results acquired followed with a list of future works and limitations.

As Pivec explained, games can greatly influence and motivate users to learn in an effective manner (Pivec, 2005). She explains that game-based learning offers an environment which helps the users to focus on the aspects being learnt by the use of adventure and trivial games. She further on claims that this result in skills and knowledge acquisition and that this active learning is the next step towards a more effective way of teaching motivated by the success such learning techniques are having.

A limitation is found in the Camera view (augmented reality) part of the application, where when the user enters Camera View all the available facts are collected, that is, they cannot be collected separately. This is due to a bug in the *EXTRA_INDEX_SELECTED_POI* Wikitude helper method. Also, the system assumes that Internet is accessible from the whole city which might not be the case.

This adventure-based learning scenario can be further extended by introducing the concept of multiplayer where users could interchange information between them for a better learning experience. An ideal solution would be to create a sub-system where users could leave comments to others which could be viewed in the Camera mode using augmented reality.

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Sci-Droid

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Abstract
The mobile industry is evolving fast and mobile phones are nowadays also very popular with people of a very young age. Sci-Droid is a project which was mainly aimed for educational purposes so as to teach young children aged from eight to ten about basic science. Using Android OS the project consisted of creating two games so as to teach students about both the organs of the body and basic chemicals which they can meet during their everyday life. This type of application is very useful in schools since it is fun and educational at the same time, making student want to play it whilst educating one self.

Keywords
Android, Children, Science, Education, Games

1. INTRODUCTION
The aim of this project was to implement a game related to science using Android OS, in our case Android OS version 1.5. We focused on the area of human body organs as well as basic chemicals and created a game for each area. The project was mainly focused on science since children aged 8 – 10 are exposed to it very mildly. Since the application was built specifically for children, it might be boring if played by adults, but children still find it interesting since it is played on a mobile phone. Also the various mobile technologies used such as touch and camera help to make the game more interactive and interesting at the same time. Another factor which makes the application more attractive to children is the Augmented Reality (see [How Augmented Reality Works]) implemented in the second game since it is still a relatively new area.

2. AIMS AND OBJECTIVES
The following are the aims that were achieved:

- The game should be educational
- It should teach students about science
- Make use of several mobile technologies such as touch and camera
- Reach even those students that do not like science
- Make use of Augmented Reality

The main aim of the Human Body game is to teach children about the human body structure and its use whilst the chemical reaction game is aimed at teaching students about the different reactions when mixing chemicals.

These aims where set so as to attract more children to our application. Needless to say, this game should be educational and at the same time a game that children would love playing (As specified in [Torrente]). Our main objective is to attract more students to this area of study. Even though they may not continue their studies on this subject, they at least would know some important aspects that are essential throughout our lives.

3. BACKGROUND
3.1 Science in Schools
Young children do not know much about science. The current [Science Syllabus] is very restrictive and does not include certain information that is essential throughout their lives. Children focus most of their attention to subjects like Mathematics and English but they seem to forget that subjects like Science exists.

At secondary schools when these children are faced with the opportunity to select some subjects to continue studying, many students give the impression that they are afraid of science subjects such as Biology and Chemistry and they are normally labeled as being boring, in fact only few pupils that choose these subjects are high flyers as the rest look like they struggle to find these subjects enjoyable. This is expressed in [Teachers want change in Science Subject]

Malta has a very low percentage of students that continue their studies and later graduate in Science and Technology subjects. Therefore something has to be done to change these results, starting from primary schools. Students should be encouraged from a young age to continue studying and exploring the science field. Teachers should encourage these children and help them view these subjects from a different perspective. It is not enough to teach students about the basic organs such as head and hands.

The method of teaching this subject to children makes huge effect. Children become bored listening to what the teacher is saying therefore the teacher only needs to make the lesson more interesting so as to capture the students' attention.

By keeping this in mind, we thought of developing a mobile application that could be used in schools for children to learn about science. Young children love to use modern mobile technologies such as touch and camera hence we thought of using these technologies to attract more children to our application. In principle this application borrows ideas from [Sushil 2004] and [Siau].

This game can catch the attention of those students that during the lesson do not pay attention to what the teacher is saying and therefore are not attracted to this subject in particular. This could help them understand more the subject and maybe explore this field by playing other science games.

3.2 Object Recognition

For the human body game, a thorough research was conducted so as to find some algorithms that are capable to detect objects. These included approaches mentioned in [Zammit 2009] [Marsza] and [Yang].

For this game, a simple algorithm was needed so as to detect an object in the picture. The picture in question should only include a person but for this game we needed the exact position of the human body in the picture. The algorithms that we found where too complex for this level, this is because they contained complex mathematical formulas. We didn't needed this complexity since as stated before the picture should only contain a person and also we didn't have much time to go through all of the algorithms we found. Therefore we decided to create a simple algorithm ourselves.

This algorithm consists of detecting the human body with a white background, and then determines the position of where the human is found. To be able to do so we had to search on how to manipulate pictures so the algorithm can differentiate the white background from the human. Therefore several picture manipulation techniques such as transforming a picture into monochrome were needed.

The disadvantage of this algorithm is that one can take a picture of an object in front of a white background, and the algorithm calculates its positions even though it may not be the human body.

3.3 Augmented Reality

Augmented Reality brings together what is real and what is computer generated so as to boost our senses as mentioned in [Azuma 1997] [Reitmayr]. Anyone can make use of augmented reality since it can be used by game enthusiasts as well as by tourists for informative reasons, such as to find a bus stop.

Since Augmented Reality was used on the Android OS, it was a bit difficult to find a toolkit specifically based on what was actually needed. A lot of toolkits were based for other OS's rather than for Android. Also many of them cannot be ported on Android since they used Flash, and Android till now does not support Flash on Android OS version 1.5. After further research an Android toolkit [AndAR] was found which ported Augmented Reality on the Android OS without the use of Flash. This open source toolkit makes use of a marker so as to identify where the Augmented Reality part should be projected. The Augmented Reality part uses OpenGL so as to draw the respective object on the marker virtually (see [What is OpenGL?] and [Olsson 2009]).

4. IMPLEMENTATION

For the Human Body game we came up with an algorithm similar to the one mentioned in [Wren 1997] that is able to detect the human body in the picture taken. The object recognition is implemented by first converting the image into monochrome. This will result into a black and white image.

The image is then considered as an array of pixels. Each pixel is examined so as to calculate whether it should become white or black. If the pixel is of a certain shade than it will be converted to a white pixel, otherwise it would be converted to a black pixel. Since a colour is represented by a value from 0 to 255, if the average of the RGB value of a pixel is less than half the white value (255), i.e. 128 then the pixel is converted to white. Else, it is converted to black.

This step results into a black and white picture of the image of the human body just taken by the user. Because of the difference in colour, the object in the image is identified, since the first black pixel that is encountered means that the object is placed there

Figure 1. Placing of the organs

After this step, the algorithm then takes the top left corner black pixel position and the bottom right corner black pixel position which are used to draw a black rectangle representing the human body.

After the above process is done, the position of each organ is calculated. These positions are calculates using a generic formula with the previously found results.

The algorithm first takes the width and height of the black box and then it starts calculating where each organ should be placed. For example, the algorithm calculates that the heart is the top centre of the human body; therefore it calculates the exact position and saves it for later reference. When the user starts playing, the input is then compared with the positions saved.

A disadvantage of this approach is that if the picture is taken with a dark background, then the object will not be identified in the image

5. EVALUATION

5.1 Human Body Game

This game was tested by taking multiple pictures which varied in the way they were taken. This could help us bring out the limitations of the simplistic algorithm we have designed to detect the human body from the picture that the user has taken.

Testing was made by taking images in front of different colored backgrounds. Since the algorithm works by converting the image into monochrome where the background will be converted to white, and the object (i.e. human body) converted to black, it resulted that for the organs to be placed correctly the background has to be light so that during conversion it can be changed to white. In a similar manner, the person has to be dressed in dark-coloured clothes so that that part of the image can be changed to black. During testing we found out that sometimes, even if one is wearing dark-coloured clothes (if they are wearing summer clothes) but is very fair-skinned, the conversion is still not successful.

Alignment of the human body was also considered during testing by for example centering the torso, or having the torso left/right justified. These worked correctly since it does not matter were the torso is within the image, it is still converted to black.

Since there is no validation on the image taken, the image could contain anything and so we could not test what would happen in the picture does not really contain the appropriate section of the human body.

We also tested the game by allowing young children to play the game which helped us improve the playability of the game. Since the organs have to be dragged using one's finger, and the mobile display could be relatively small, we realized that the finger used to drag the organs was covering the organ selected which made it difficult to place it in the correct position. So we decided to enlarge the images, which are then re-sized appropriately when they are placed in the correct position. Another difficulty which the children faced was that it was taking them quite some time to place the organs correctly, even though they were very close to the actual result. As the game's main aim is to teach students about the organs, their use and their approximate position, we decided to increase the range of the accepted solutions, but when an organ is placed within the right range, the image sticks to the exact position.

Children who tested our game, found it very interesting since they liked the idea of taking a picture and then placing the organs on oneself. Playing a game using the touch technology of the mobile device made it more appealing.

5.2 Chemical Reaction Game

The main features we had to test were the accelerometer and the use of the marker throughout the game which implies the virtual beaker as well.

As stated before, to answer a question the user must tilt the mobile device backwards, thus it is important that the device is not tilted while answering a question, else the result would be computed without allowing the user to "shake" the selected objects.

We also had to test the way the beaker appears on the screen. The marker has to be kept visible on the mobile display at all times; else the virtual beaker would instantly disappear. This was found to be quite trouble-free but this was not the case when the user tilted the device to compute the result. Since the device has to be tilted, it is very possible not to keep the entire marker visible. Because of this, the beaker will disappear and when the whole marker is made visible again, the beaker will not have its colour changed.

This game was also found to be appealing to the children who tested this game especially the accelerometer technology which was used throughout the game as they liked to shake the device for computing the outcome and to simulate a spillage of the selected objects.

Figure 2 - Simulating a spillage

6. FUTURE WORK

As one can see from the Evaluation section, there are features which could possibly be improved, and as well as other features which could be added to the application.

An important feature which could be improved in the Human Body Game is the validation of the image taken by the user. Users can still play the game whether the image taken is that of a torso, a whole human body or even any other object. Besides this, since the application is aimed for young children, it would be more probable that the picture is taken incorrectly. Thus it is very essential that this problem is removed, or at least improved.

An interesting characteristic which could be added to the chemical reaction game is to give the user more control of the marker. Currently, when the marker is removed or is not fully visible on the camera preview, the virtual beaker simply vanishes from the screen. The application could also detect the removal of the marker so that it can simulate another event such as the dropping of the beaker resulting in the beaker being shattered. If a user is given a number of "lives", this could be used so as to remove one life.

A feature which could be added to both games is to include levels, such as beginners' level and advanced level which could be used to direct the game to different age groups by adding harder questions and organs to the games. Points could also be included to both games, so that when one ends playing a game, he/she can be presented with a ranking of the user's own scores as well as those of previous players.

7. CONCLUSION

This project required to create a mobile application to teach students using Android about science. The age chosen was 8 – 10 since children at that age are old enough to use a mobile phone whilst on the other hand they are still small and have fun to play with it. Some limitations of the application might be that in the first game the human body is recognized using object recognition which does not identify the human body as such but it just cuts the object from the background whilst in the second game on the other hand it can be played normally even without the use of the Android marker which can be a disadvantage since it will mean a lot of the game fun will be lost. In spite of the limitations present in the application, the overall results were as we were expecting. Since the aim of this game was to educate children while they are enjoying themselves, we feel that this goal was achieved as we received a very positive feedback from the children who tested our application.

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Future Directions

Short Papers

Identity and professional learning with mobile technologies: a case study of trainee and newly qualified teachers

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Abstract

This paper presents preliminary findings from a UK based research project exploring trainee and newly qualified teachers' use of mobile devices during their initial teacher training and subsequent first year of teaching. Using a mixed methods qualitative approach with a cohort of trainee religious studies teachers, data were gathered to identify both the barriers and the potential usage of such devices to augment their professional learning. This paper, reflects a slightly different focus which featured as significant in the accounts of research participants, notably, the issue of emergent teacher identity and the ways in which mobile devices influenced and shaped professional identities within a specific socio-cultural context, in both formal and informal learning environments. Drawing on concepts of 'appropriation' proposed by Pachler *et al.* we argue that while mobile devices have the potential to enhance the professional learning of trainee teachers and ultimately to impact upon the learning experiences of pupils', critical attention must be given to the ways in which these devices might mould trainee teachers' sense of professional identity and the effects that this might have upon their teaching practice.

Keywords

Identity; appropriation; mobile; trainee;professional

1. INTRODUCTION

This short paper presents initial findings and conceptualisations about the potential of ubiquitous, always connected mobile devices (in this case, iPhones) to influence and shape the changing professional identities of a group of trainee teachers moving into their first year of full-time teaching. This transition is identified as a crucial period for the construction of professional knowledge and identity and the development of identity and beliefs about teaching is enhanced by opportunities for formal and informal interaction and communication(Griffin, 2003; McCormack et al., 2004).

The project is situated in a variety of different contexts which include the formal learning contexts of the University and secondary schools (placements and permanent posts), the informal 'life-worlds' which characterise the participants in their informal spaces, and the third space or place which has been defined as the space between entirely formal and informal contexts for learning (Oldenburg, 2000). The project was co-funded by the Training and Development Agency in the UK as one of their small ICT research grants (http://www.tda.gov.uk/) and the Institute for Learning in the University of Hull and follows eight trainee religious studies teachers during the latter part of their University Post-Graduate training programme and the first year of their first teaching post. It seeks to investigate the contribution of using mobile devices upon pedagogy and practice and the concomitant issues which influence the formation and development of their identities. The specific research questions underpinning this study include:

- How is the professional identity of novice teachers (trainee and newly qualified) influenced and affected by the use of mobile technologies?
- How do novice teachers use mobile devices to develop their professional knowledge, learning and identity?
- What issues and tensions arise in terms of professional identity when trainee and newly qualified teachers employ mobile devices in their professional settings?

2. THEORETICAL BACKGROUND

2.1 Professional identity

Interest in the subject of teachers' professional identity has increased considerably over the last decade or so, with calls for teacher education to begin to engage with concepts of the teaching self as a critical element in meeting the needs of student teachers (Bullough, 1997; Volkmann and Anderson, 1998).

While particular views of identity formation have been critiqued as monolithic and relatively fixed, (Erikson, 1968; Mead, 1934) the contrasting post-structuralist approach regards the formation of identity as a dynamic process in which the self is continually in a process of becoming (Deleuze and Guattari, 1987). Identity is therefore fluid, partial and receptive to a process of continuous interpretation and re-interpretation (Wenger et al., 2009; Zemblyas, 2003). Through this lens identity is intricately bound up with the discursive, social and political context through which it is constituted and reconstituted and significantly, does not comprise of a single homogenous notion of self. Rather it is multifaceted and will consist of aspects of the self which conflict and compete and which are historically and socially contingent (Beijaard et al., 2004). Crucially, the professional identity of teachers will be shaped and recreated through their own agency and professional learning, bounded within the broader socio-cultural context in which they work and live (Pachler et al., 2010).

Research indicates that student and newly qualified teachers frequently experience many tensions and challenges in managing their emergent professional identity and shifting away from the lay theories and naive beliefs, which characterise the novice practitioner (Wishart, 2009). This process is both supported and complicated by the emergence of mobile technologies, which have the potential to play a significant, but largely unpredictable role, in influencing the nascent identities of student and newly qualified teachers.

2.2 'The Appropriation' framework

Various theoretical approaches and perspectives inform this study but predominantly it adopts a socio-cultural design based around the concept of 'appropriation' developed by Pachler, Cook and Bachmair, (2009). Notwithstanding some of the problems with utilising this theoretical framework, we maintain that it represents a departure from traditional techno-centric approaches and thus has some potential benefits for understanding the relationships between the use of mobile devices and ways in which professional identities are enacted. Their theory is derived from the work of Giddens and his work around structuration which was developed to bridge the gap between what he saw as an unnatural dichotomy between the individual at a micro level and societal forces at the macro level (Giddens, 1984). Pachler et al. have adapted this theory to explain the phenomena of mobile learning within social milieus. Their framework situates mobile technologies as 'cultural' resources or artifacts and theorises that the ecology of mobile learning is shaped and mediated by the interplay of the learner's own agency (i.e. their capacity to act on the World), the socio-cultural structures within which the learner exerts their agency, and the practice of media use in learning, both formally and informally.

Early attempts to understand and theorise the place of mobile technologies in education focused mainly on the technology itself whilst later studies focused on learning in informal contexts and more recently on the aspect of mobility itself. The appropriation framework which Pachler et al have developed offers a more nuanced interplay between the various factors which considers how the user, their surroundings and the technologies all play a part in the construction of the teacher's professional identity when they use mobile technologies. It enables us to theories about how these complex factors might interplay to mould professional identity.

In late modern times there is considerably greater responsibility on the part of the individual to make their own life choices and to act reflexively in order to make sense of these choices (Giddens, 1984) . This contrasts sharply with modern or traditional societies which provided more clearly defined roles, structures and traditions by which to guide individual action. Schools are often perceived to be bastions of modernity in the sense of that they impose rigid structures, traditions and cultural values, norms and expectations on their individual members. This presents a considerable challenge for trainee and newly qualified teachers who are required to negotiate and mediate their way between different learning ecologies in the course of the early stages of their careers, including the University components of their course, two work-based placements and a significant personal element in which the influences of their own life worlds can often be sharply contrasted with each of the other formal elements.

> 'The more post-traditional the settings in which an individual moves, the more lifestyle concerns the very core of self-identity, its making and remaking' (Giddens, 1990: 81).

We are interested therefore, in how these forces and challenges impact upon the self-identity and professional identities of participants in the study and what part technological devices, such as mobile devices, play in determining how these identities are shaped and altered. In particular we are seeking to explore how the use of a mobile device within a variety of different contexts affects the self-identity of trainee and newly qualified teachers and what impact this has on development of their emerging professional identity and professional practice. Wishart reported that trainee teachers often experienced unease and uncertainty about their role when they used mobile devices in placement schools (Wishart, et al 2005) and these findings are supported by evidence from veterinary and clinical studies where the devices have been tested rather more extensively (Whittlestone, et al 2008). Of particular interest in this context are the arguments which Wishart has made which suggests trainee teachers have not yet developed a coherent professional identity and are especially vulnerable to the pressures of school cultural norms and practices which may view the mobile device as a disruptive technology and influence (Wishart, et al., 2005).

3. METHODOLOGY

Identity has been regarded as essentially a 'reflexive project' (Giddens, 1990) which individuals work on and reflect about in an iterative fashion creating what one author terms 'biographical narratives' (Gauntlet, 2002). It is important, therefore to recognise the importance of capturing these 'biographical narratives' in as pristine and uncontaminated manner as possible and to this end we have devised a largely interpretative methodology which places considerable emphasis on the production and collection of primary data from the participants themselves. Students were required to produce regular audio log every fortnight, using the iPhone itself, reflecting on their experiences of using their mobile device and its impact on their self-identity. In addition students were asked to attend a series of focus group meetings in which they were encouraged to share their experiences of using the device in a largely unstructured and open format. Semi-structured interviews were conducted with each of the participants at three intervals during the course of the eighteen month project. These interviews were all transcribed and analysed using a grounded theory methodology (Strauss and Corbin, 1994). The initial findings and emerging themes from this data are presented below.

4. INITIAL FINDINGS

A number of participants have expressed some concern about using their smartphones in the classroom where pupils are usually forbidden from bringing such devices into school.

All of the participants experienced working in placement schools where the use of mobile phones by students was prohibited and for some this was described as 'rubbing their noses in it' (student 1) when pupils were clearly forbidden from doing likewise. These concerns echo the findings of Wishart (2005) who also identified role identity of trainee teachers as a potential problem and inhibitor in terms of using new technologies in a classroom context.

There is a sense amongst the students of participating in a slightly subversive activity and this has induced varying degrees of concern and self-questioning about their role and their professional identity. Are they upholding or undermining the school's values and cultural practices when they use these devices, and how are they perceived by members of the school community (pupils and other staff) when they perform in this manner?

A second theme which is beginning to emerge in terms of professional identity relates to the student's levels of confidence and skills, which some have simplified into a dichotomy of 'digital natives' and 'digital immigrants' (Prensky, 2001). Using Prensky's definition all of our student participants would fall into the 'digital native camp yet the findings from the baseline and initial interviews suggest this is too simplistic, particularly in relation to the use of the technology for professional rather than social purposes. Many of the students did not define themselves as digital natives in the initial interviews and the overall patterns of usage by our participants was not uniform. In many cases, even after exposure to the devices for some three months, the mobile device was left at the 'classroom door' or secreted in a handbag. It has not yet become seen as an essential and integral teaching aid by all of our sample. This may be due to a range of factors which we continue to investigate, including the issues of professional identity and subversive activity, which we describe above.

It is also clear that all but one of the participants own and use a separate phone for all communications such as calls and texts. Some noted that this duality probably prevented them using the smartphone as often as we had imagined and might be seen as a prohibiting factor in the regular use of the device as a classroom tool. This reinforces evidence from much larger studies and investigations which clearly indicate that most mobile phones are used to make calls and texts and only a small minority of users explore or indeed exploit the other features which make a smartphone so unique. (Katz and Aakhus, 2002). It is perhaps not surprising, therefore to find many of the more sophisticated features (e.g. GPS) have not yet been used by the participants in a classroom setting, and we might theorise at this early stage that more varied use of the device would be facilitated by ownership of a single device rather than two.

It is, however, interesting to note, even at this early stage in the project, how far some of the participants have personalised their device, investing it with personal features and qualities such as new Apps, ringtones and protection devices (e.g. covers). In these cases participants report a close bond to the device with concomitant interest in how it defines them as a teacher and professional. For example, it enables them to demonstrate a greater sense of independence (e.g. allowing them and their students to gain access to the Internet without using the school's obsessively tight security protocols); it demonstrates their connected and networked presence (e.g. by being able to post directly to their blog or web-site); and it enables them to stay connected to their various network of contacts (e.g. other students in different placement schools) whilst simultaneously undertaking their role in the placement school they are currently working within. For these students there is an emerging sense in which they are coping with multiple or subjective identities through the mediating influences of the device itself, and in doing so developing different modes of working with their students.

5. CONCLUSIONS

The initial data reveals a number of emergent themes in how the device is shaping the personal and professional identity of the student teachers. There is a strong sense of ownership of the device and desire to explore the potentiality for the classroom. Students are finding that the device effects the relationship between themselves and their students and themselves and their colleagues in school and that a dichotomy between the cultural practices associated with the device in the "non-school" worlds and the "school world" expressing reservations of the use of the device in the school setting. The immediacy of the device has had impact on their practice and this has impacted on their own sense of professional identity.

At the time of writing (June 2010) we are still at early stages of this project (3 months into an 18 month project) and whilst there are some emergent themes on personal use, the nature of subversion (working around imposed restrictions) and personal identity as a trusted professional and the breaking down of the socio-cultural structures still remains to be fully explored.

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Augmented Reality & Mobile Learning – some Lessons Learned

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Abstract

We here describe experiments with a potential mobile augmented reality genre for learning, a so-called 'situated simulation' (sitsim). Several prototypes and their key features and functionalities are presented and discussed as they have evolved over several years of design and development work. A particular focus is on the use of sequences of events and actions in the virtual environment. This opens up for new kinds of story lines and narrative structures, which are then described and discussed in relation to narrative theory. Finally, design features for further research and development are suggested.

Keywords

Mobile augmented reality, situated simulations, sitsim, iPhone, genre design, situated learning, double descriptions.

1 INTRODUCTION – MOBILE AUGMENTED REALITY AND SITUATED SIMULATIONS

A Situated Simulation (sitsim) is a subcategory, or a subgenre, of nonhybrid mobile augmented reality (MAR) systems based on smartphone terminals.[i] In most augmented and mixed reality systems live video input (of the real environment) from the phone's camera is combined with a 3D graphics layer presenting a virtual object or environment (Milgram and Kishino 1994; Milgram and Colquhoun 1999; Papagiannakis et al. 2008; Knopf 2008).[ii] A situated simulation, on the other hand, has a 'clean screen'. This means that there is no use of a live video feed upon which the 3D graphics layer is added. In a situated simulation the display of the virtual environment covers the whole screen, and there is approximate identity between a) the user's visual perspective and perception of the real physical environment on location, and b) the user's visual perspective of the 3D graphics environment as it is represented on the screen. This relative congruity between the real and the virtual perspective is obtained by allowing the position and movement of the virtual camera inside the 3D environment to be determined by the GPS-coordinates (positioning), the accelerometer (vertical movement) and magnetometer/ electronic compass (horisontal movement). As the user changes position and moves the phone in real space, the perspective inside the virtual space (on the screen) changes accordingly and with a dynamic refresh and frame rate high enough to achieve continuous movement (Liestøl 2009a).

This paper reports on a series of sitsims that have been developed and tested in real user environments over the last couple of years (2008–2010). The purpose here is to present a kind of *inventory of the features* that so far constitute the status of situated simulations as a prototyped mobile augmented reality genre, with particular focus on the narrative potential of sequences containing events and actions. All the sitsims discussed here have historical topics.

2 EARLY INSTALLMENTS – BASIC FEATURES

The first two sitsim prototypes, The Oseberg Viking Ship and Mission Dolores, (Liestøl 2009a, 2009b) established and employed some basic features:

Matching real and virtual. Because of the sitsim's nonhybrid, clean screen solution there is no simultanous graphic match between the real and the virtual on the screen. The real stays real outside the screen and the virtual environment displayed there. Thus a temporal link of continuity needed to be established, relating the real and the virtual. This is done by introducing a transition mode, a simplified, 'naive' version of the real on the screen, which can be easily identified by the user as a representation, a simulation. When the relationship is established the user is ready for the full resolution a graphic reconstruction of an historic past object, in this case The Oseberg Viking ship or the Mission Dolores.

Static 3D objects and environments. A virtual environment that cannot be manipulated by the user, that is it cannot be modified. The 3D objects in this environment do not change over time, they are static.

Links. Although the virtual environment in this version of a situated simulation cannot be modified or changed, the user may navigate and access information via links. These hypertextual link anchors are spatially placed and the link icon is itself connected to either an object or a position in the environment by means of a visual string. Because of these characteristics it has been given the name 'balloon link'.

Link layer. In order to be able to switch between an experiential mode (without active visible links) and an informational mode (with visible active links) the link layer can be turned on and off. This makes it possible to choose between the two modes of (re)mediation: immediacy and hypermediacy (Bolter and Gruisin 1999).

Detail view. Due to the hardware limitations of the platform used in these tests (iPhone 3GS), the poly count of displayed objects is limited to less than 20k in order to obtain an acceptable framerate. Thus in order to view a detail of optimal resolution the general environment is substituted with an abstract environment only showing the detailed object. The transition between the two 3D environments is achieved by means of a 'repositioning' of the object from its original place (low resolution) to a position close up in front of the user's position/camera (high resolution). This movement creates the impression that the object 'comes up to' the user and displays itself.

The main purpose with the design and testing of these early sitsims was to establish a basic and intuitive user interface

The Oseberg sitsim was tested with elementary schoolchildren (3. grade) and high school students (10th grade). In both cases the classes where divided into to groups, one got introduction to the use of the system, the other group did not. There were no detectable differences in how they used the application. All responded that it was intuitive to use (Liestøl and Rasmussen 2010).

3 THE PARTHENON (TRANSPARENCY AND OVERLAY)

In a sitsim displaying a reconstructed version of the original Parthenon temple on the Acropolis in Athens, the prototyped application was extended with two new features: transparency and overlay.

Transparency. Since GPS signals are not accessible indoors, and in the case of the Parthenon, the visitor is restricted to only move around the building, not inside its remains, there is a need to look inside, through visible obstacles like walls, columns etc. In the print tradition, a solution to this problem is called cut-away illustration and is frequently used in books on architecture and in travel guides. In our case we used partial and full transparency. It was partial in order to still be able to see the outer limits of the construction (the architectural context), and full when the display of objects inside is the primary focus (see figure 1).

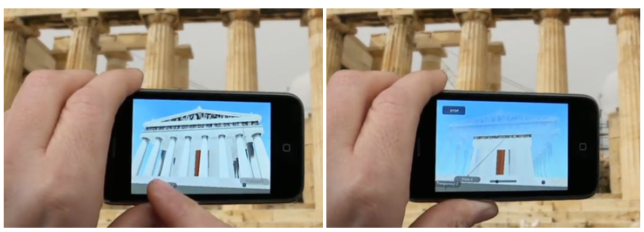
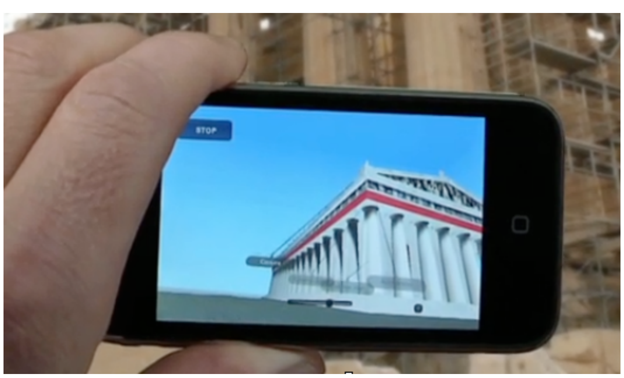


Figure 1. Transparency: Reconstruction of The Parthenon Temple on the Acropolis in Athens. Here the temple is observed from the east the 'Transparency 1' link is activated. This gives us a view of the cella and the position of the frieze. The columns and upper parts of the Parthenon are still visible in semi-transparent mode.

Figure 2. Overlay: Parthenon observed from the west. The user has chosen the 'Architrave' link, thus the lover compartment of the entablature resting on the column capitals is marked with a transparent red banner while a voice over provides additional information.

Overlay. Another solution borrowed from the print tradition of architecture is the overlay marking. To explain the elements of architecture and their corresponding names, balloon links were stringed to the objects. When these are



activated, partly transparent color overlays mark the extension and limitation of each element; this is also described by a verbal audio commentary (see figure 2).

4 THE TEMPLE OF DIVUS IULIUS (USER GENERATED LINKS, ONLINE MATERIAL AND SEQUENCES OF EVENTS & ACTIONS)

In the most recent of the prototyped situated simulations - one reconstructing the Temple of Divus Iulius (The Temple of Deified Julius Caesar) anno 29 BCE in the Roman Forum - we also made it possible for users to create links, and we included a sequence of actions and events.

User generated links. In the sitsims mentioned above, the producers of the application provide all links. Users are limited to navigate and access the information that is provided for them to acquire. In the most recent version of the sitsim application users can create, name and position their own links. These user-generated links are of two kinds: either a) they link to and display a node of written text when activated, or b) they link to a web page. In both cases, the user-generated information is stored on a server independent of the local application (on the actual iPhone in use). In the case of the web page, the application applies a built in simple web browser which is displayed inside the virtual environment on parts of the screen. This also makes it possible to update material for use in the simulation independent of the application itself. Users can also comment on other users' links, thus turning the situated simulation into a spatial constructive hypertext (Joyce 1988).

Figure 3. Placing a link in front of the Temple of Divus Iulius in the Roman Forum. Here the user has just added and placed a balloon link (the vertical white line) in front of the temple's rostra, and is about to give it a name and turn it into a hypertext node of written verbal text.

Figure 4. Accessing classical texts about events related to the Roman Forum. In this case the user has activated the link 'Classical resources' just in front of the Temple of Divus Iulius. Nicholaus Damaskus book *Life of Augustus* is viewed in the internal browser.

Sequence of actions and events. While the previous sitsims all display static objects, the simulation of Temple of Julius Caesar also include a sequence of events and actions. While studying the Temple, after activating the 'Altar' link the user is asked if he or she wants to experience the actions and events that led up to the building of the temple. If confirmed the whole simulation scene changes and moves fifteen years back in time to the days following the murder of Julius Caesar on the Ides of March 44 BCE.

As the user turns towards the sound of a crowd s/he can view a large group of people who have gathered on the other side of the Forum, towards the Capitoline hill and two human figures are clearly visible on the Rostra, the speaker's platform. As the user moves across the Forum the scene becomes easier to understand. On the Rostra surrounded by a crowd is Marc Anthony presenting the euology for the murdered Dictator Julius Caesar. Caesar's dead body is placed on the Rostra inside a miniature of the Temple of Venus Genetrix out of sight for the public. On a wooden pole next to Marc Anthony a wooden pole is erected, which slowly rotates. On top of this pole is a wax effigy of Caesar's beaten body. This scenario is based on Appian's description, (Appian 1996)

After listening to parts of the speech (in Shakespeare's famous interpretation!) the scene dissolves and the crowd – now angry after Marc Anthony's presentation – has gathered on the other side of the Forum, in front of the Regia, Caesar's official residence as Pontifex Maximus. There they have created a pyre and Caesar's body is cremated in front of the Regia. On the same spot an altar was soon raised and later the Temple of Divus Iulius built by Emperor Augustus. The ruins of the altar and the temple remain today and form the real (physical) basis of our simulation.

With this sequence we have introduced a new element and turned the sitsim into a potential device for storytelling, a narrative machine. As this sitsim now is designed and described it becomes a narrative environment the user navigates from within, a walk-in-documentary, or a 'situated documentary' (Höllerer 2004). In the case of the euology and the cremation, the user is experiencing a flashback, an asynchronous relationship between the order of events at the level of discourse and the order of events at the level of story (Genette 1980). Our user's experienced story starts with the new temple in 29 BCE and moves back to an evening just after the middle of March in 44 BCE (the euology), then moves to an event later the same evening (the cremation), then the erection of the altar, and finally back (or forward) to the starting point, the completed Temple in 29 BCE (see figure 5.). In narratological terms the exploration of the Temple is in the scenic mode. According to Genette this is where discourse time and story time is identical when it comes to duration (this is also the

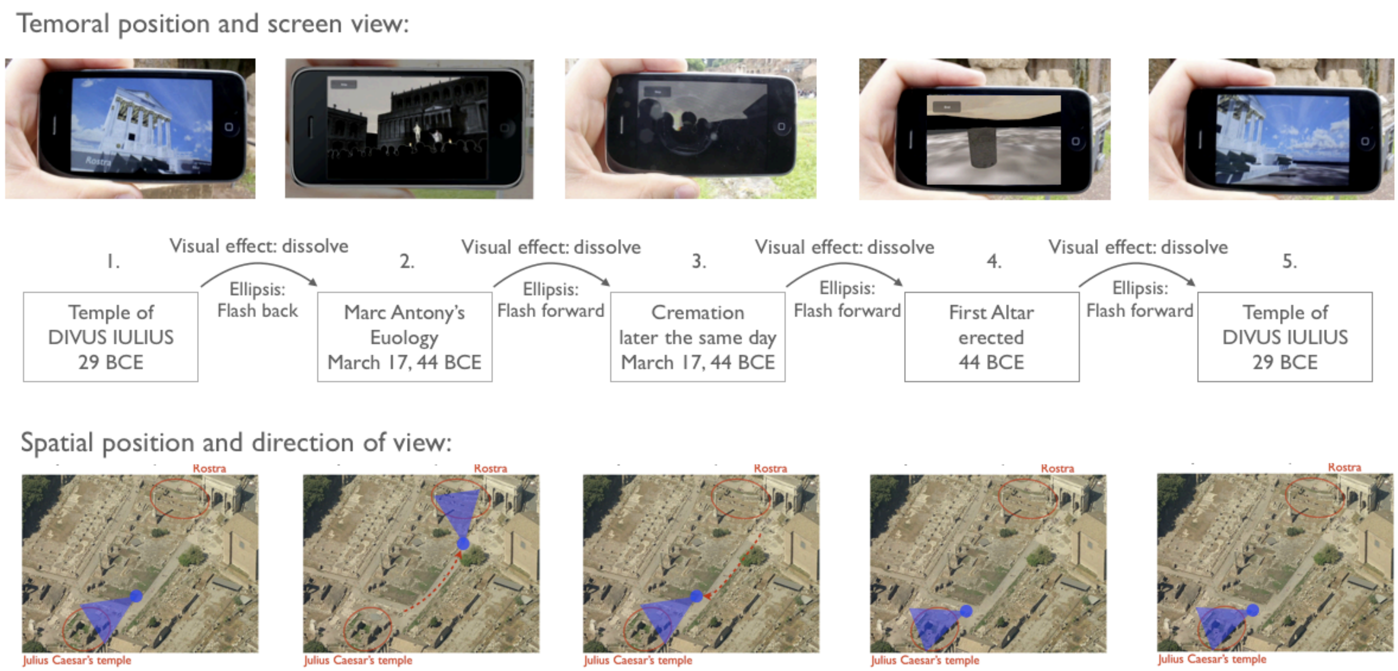


Figure 5. The temporal and spatial positions in the user sequence. The temporal flash back loop at the level od discourse in the user sequence is repeated and mirrored in the user's spatial movement.

mode that is most common in computer games). In the described user sequence the flash back loop is made possible by four incidents of ellipsis (that is, where story time has no extension at the level of discourse). In the first incident there is flash back, in the three others, flash forward. The temporal flash back loop is supported by a spatial loop, the user's physical movement on the Forum, from the eastern side, near the Temple of Divus Iulius to the Rostra on the opposite side, and back again.

During this loop the user has also been shown, and hopefully learned about, the background for why the Temple of Divus Iulius was erected by Caesar's grandnephew and heir, Octavian, later Emperor Augustus.

5 USER TESTING AND EVALUATION

All the sitsims described here, except Mission Dolores, has been systematically user tested and evaluated. The Parthenon simulation was evaluated in a field trial with BA-students at the Norwegian Institute in Athens. The students used the system in pairs, one phone and outlet for two stereo earplugs/headsets. The feedback was positive. The students particularly found it valuable to view the reconstructed temple as a totality on location. However, some noted that they did not want the digital reconstruction to compete with the real Parthenon. Most popular were the transparency features and the detail views.

The Temple of Divus Iulius simulation was tested with BA students studying Classics at the Norwegian Institute in Rome. Again the feedbacks from the students were very positive. They valued transparency, marking and detail views, and some of the students characterized the simulation of events and actions (Mark Anthony's euology as 'hair raising' in a positive sense of the expression). When asked if the system could substitute a human guide (f. i. a professor of classical studies) the answer was negative. But the simulation was considered to be a valuable supplement to a scholarly guide. Detailed analysis of these evaluations will be published elsewhere.

6 CONCLUSION – FURTHER DESIGN AND DEVELOPMENT

The development of the sitsim genre prototype is conducted in the context of *digital genre design*. An overarching approach to this endeavour is to develop a method for how to create innovative communicative and expressive forms based on emerging digital technologies, such as mobile augmented reality on regular smartphones. Feedback from the user testing shows that we are on the right track. The purpose now is to make the sitsims available to larger user groups, for example via Apple's App store for free download. This will hopefully generate more feedback so that we, the developers can explore the potential of this 'genre' further.

In future versions of the Temple of Divus Iulius sitsim we also plan to include different interpretations of both objects and events. The current version of the Temple is Corinthian and based on german scholar Christian Hülsen's interpretation, but the temple might have been of the composite style. Descriptions of the events surrounding Marc Anthony's speech also differ, depending on which classical source one read, Appian, Suetonius, Dio or Plutarch. In the current version we used Shakespeare's interpretation from his tragedy *Julius Caesar*, which was again based on Plutarch's account. To be able to switch between alternative interpretations of historical data/accounts will add a valuable dimension to the application

Learning is contextual. It is a function of the activity and culture in which it occurs. Lave and Wenger (1991) call this pedagogical approach "situated learning." In situated learning the contextual space and place are central. With mobile augmented reality and situated simulations it is possible to support and extend the "situatedness" of learning and education in new ways by means of information technologies (IT). This is not limited to historical topics as described above. It extends to any discipline or subject matter that may benefit from making present what is absent, be it past, current, or future topics. The combination of the real and the virtual (what is simulated) also provides added experience and value. It gives the learner information from multiple sources—what Gregory Bateson in his epistemology has deemed "double description." (Bateson 1988) In his view, the combination of two sources of information generates a new type of knowledge and experience, as is the case with binocular vision (of depth). The notion of double description has been an important perspective in combining the virtual and the real when designing the sitsims presented here, and we believe it has a great potential for future solutions.

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[i] The easiest and quickest way to understand how a sitsim works is to watch one of the short video demos at <www.inventioproject.no/sitsim>

[ii] Today such systems have become widely available on smartphones running for example iOS and Android. Examples are the Augmented Reality view in the Layar Reality Browser <www.layar.com>, and the Nearest Tube application from from Acrossair <www.acrossair.com>

Designing Ambient Games from a Process-oriented perspective

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Abstract
Ubiquitous learning and gaming are emerging as important characteristics of the digital generation. Developments in various fields of research point to the importance of adopting process-oriented approaches that capture key task and person-oriented interactions manifested in technology-intensive collaborative learning environments. A process-oriented methodology is outlined and applied to the design of domain knowledge. This process is contextualised in designing an ambient gaming experience about the history of the capital city of Malta, Valletta. The model also discusses how inter-player interaction and communication with field experts can be used in a learning context for a multiplayer game. The proposed model can be used to develop protocols for designing and evaluating technology-mediated learning using interactions profiles.

Keywords

Ambient gaming, mobile gaming, game design, ubiquitous learning, technology-enhanced learning, design models.

1. INTRODUCTION
Explorations and experimentation with emerging technologies is leading to profound pedagogical reflection. Content in every domain is becoming available globally and is free, making institutions rely on 'cloud services' for more of their critical functions. Mobile technologies offer opportunities for personally managed learning within and outside the classroom through technology-mediated networks of interaction.

Gaming is emerging as a significant mode of autonomous learning establishing itself as a personal approach for the 'digital generation' to interact with certain domains of knowledge. In the repertoire of this generation, gaming has established itself as a life-long and life-wide enterprise complementing initial formal education. It has become a persistent way of interacting with life comprising the physical environment, or representations of it, the intra-individual reality through reflection and the world of ideas and conceptual artefacts (Bereiter 2002). Gaming is transforming the most important aspects of their lives – communication, learning, entertainment and social interaction.

Ambient gaming extends this interactive learning experience by integrating the virtual with the physical environment making possible the truly constructivist and constructionist approach of 'pedagogy in context'. The role of the portable gaming device becomes more complex as it mediates interactions with the game domain content, with the external environment and with competitive or collaborative colleagues.

The integration of all these elements in mobile gaming creates a need for a different frame-of-mind to conceptualise the learning experience and the design of games. It demands detachment from models that emphasis learning as a process of content transmission and move on to a process-oriented pedagogy that reconceptualise learning and knowledge building in terms of dimensions and levels of interaction with the physical world, with conceptual artefacts and with the evolving intra-individual gaming-learning experience.

Developments in various fields of research point to the importance of adopting process-oriented approaches in analysing Technology-Intensive, Collaborative Learning Environments (TICLEs). In such contexts key intrapersonal and psychosocial processes give rise to various levels of interactions. Skill imitation (Frith & Wolpert, 2003), negotiation and argumentation (Dillenbourg *et al.* 1996) generate task-oriented interactions related to competence development along the domain and technology dimensions. The psycho-social processes of impression formation (Kreijns, Kirschner & Jochems, 2003), mentalising (Frith & Frith, 2003), social monitoring (Jost, Kruglanski & Nelson, 1998) and interpersonal communication generate categories of person-oriented interactions that characterise technology-mediated group dynamics. In this way the group of gamers collaborating through mobile/ambient gaming is capable of promoting reflection about the interaction between the intra-individual reality and the external technology-mediated experience. The process of interaction with the game content contextualised within the external environment and with colleagues interacting from a different psychological and spatial perspective, challenges each gaming partner to accommodate one's internal experience. This internal transformation is manifested as a change in one's attitudes, beliefs, behaviours, understandings and skill level about gaming and the domain itself – the elements that constitute one's idiosyncratic experience with technology.

Bonanno 2005, 2008, 2009a&b, 2010a,b&c propose a process-oriented methodology to analyse and manage TICLEs. Inspired by Constructionist and Connectionist epistemologies, the proposed framework categorises interactions along the domain, technology and community dimensions, and across three pedagogical levels. These levels progress in emphasis from 'acquisition', through 'participation' to 'contribution' modes of learning. The model organises interactions at the experiential and metacognitive levels for each of the three dimensions. This scheme has been used to develop protocols for designing and evaluating TICLEs using the type, frequency and direction of interactions as fundamental design elements. Interactions profiles along the three identified dimensions for different TICLEs can be developed. Analysis of such profiles may lead to qualitative and quantitative evaluation techniques as well as formative and summative assessment mechanisms.

This paper focuses on the design of the domain model for a mobile/ambient game proposing an innovative interactive way of experiencing a domain of knowledge like History. The discussion of how one can learn History in an innovative technology-mediated way will be contextualised through an ambient game about the history of the capital city of Malta, Valletta. The model regulating the deep structure of the game will determine user's interaction with the information, concepts, themes and problem situations in history and how these levels of interactions can be further enhanced through the integration of the external environment and connection with fellow gamers. The main objective is to provide an immersive learning experience enabling users to interact concurrently with real life contexts and virtual simulations of historical places, events and historical figures. Thus while moving through the city playing the game as one of the proposed historical roles, the game interacts with 'hot spots' on key historical sites that initiate interactions in the form of virtual tours or tutorials. The game will offer a multiplayer mode that enables players to interact amongst themselves in real time.

2. DESIGNING THE MODE OF INTERACTION WITH THE DOMAIN

Designing a learning experience through ambient gaming from a process-oriented approach demands the identification of those categories of interactions that will create a particular experience based on prescribed parameters. The level of interaction within a subject comprises the hierarchy of learning outcomes ranging from basic facts, concepts, principles and rules, problem-solving and attitude formation about the domain. The basic level of interaction with the history game about Valletta will be designed to present facts about different aspects of Valletta. A higher level of interaction would be the organization of information around concepts that characterized the development of the physical structure of the city. The initial driving principle adopted by the knights of Malta was to build 'a city from gentlemen for gentlemen'. This implied innovative approaches for designing the city's infrastructure, defence system, recreational facilities, communication system and all other services. In building these one had to apply procedural and relational rules that provided solutions to numerous problem situations. In interacting with these levels one may develop a personal attitude towards the city that determines how the individual reacts to and interacts with this place and its history.

An effective pedagogical strategy to deal with such complexity is to organise these interactions around core themes that represent expert way of organising knowledge and behaviour. The History of the city of Valletta will be organised around four core themes. An *evolutionary perspective* organise facts and events along a time line giving detailed descriptions of the different eras of the city, starting from a barren peninsula in early and medieval times through the different historical layers that are now evident. A second mode of interaction with historical knowledge is achieved by organising it in a relational mode making it possible to explore how *structure relates to function*. In this case the focus will be on the range of architectural features and buildings that constitute the city and how their make-up relates to some particular function. Another organising theme is *universality versus diversity*, or how universal social, political, economical and religious rules are evident in the structure and development of the city. Yet one has to learn how these universal rules and principles had been adapted to accommodate to local circumstances. Knowledge about Valletta can also be organised using a systems approach that describes how *equilibrium* has been achieved through time in the local social system. This elaborates on the checks and balances that existed over time to maintain harmony and functionality amongst the various elements (physical, administrative, economical, religious) of the social system.

3. STRUCTURAL AND METAPHORICAL DESIGN

The interactions along the proposed domain themes have to be modelled in a way to create an engaging mode of interaction through the game. Thus each theme is developed around a cluster of interactions that in turn are personified in game characters. The *evolutionary perspective* will be personified by the *Explorer* game character. Facts about the geographical and topological features of the Valletta peninsula will be provided by the game while user (through game character) explores terrain both from land and sea. The mission of the *explorer* will be to establish the best encampment position by identifying and collecting available resources (limestone, wood, food, water). The best encampment position, that is, the one that will make it possible to gather enough resources to move on to the next level will be the place where currently one finds the Palace of the Grandmaster. Besides resources the game provides user information about geographical orientation, wind direction, distance from the sea and natural features that may be exploited (such as viewpoint positions to monitor surrounding terrain).

In this mode the ambient component can be activated either through hot-points on the surrounding building or through GPS synchronisation. When user is playing the game in the confines of hot points in the external environment, the ambient mode is activated in the form of a virtual interactive learning experience. The game environment will be changed into a simulation that user may interact with to explore the different geological and topological features as a function of geographical (GPS) coordinates. From the particular geographical position of the user, the game will challenge him/her to identify structural characteristics in the surrounding terrain or constructions indicating how buildings were designed to counteract or adapt to environmental conditions and social needs during the course of time.

The second mode of interaction with the history of the capital city of Valletta organises facts, concepts and principles from a relational perspective – how structure relates to function. The game provides historical information and enables user to explore the concepts and rules employed in the construction of the various buildings and spaces giving particular attention to the exploitation of geo-physical features. This analysis is carried out in relation to any administrative, military, religious, health or leisure functions of that particular construction. The gamer adopts the role of an architect having the mission to build the fortifications surrounding the peninsula, a range of military, administrative, religious buildings together with recreational and leisure-related constructions. The game will lead user through a serious of options about principles to be used in developing a particular structure according to the original concept of the Knights for the city. The ambient component of this playing mode includes various wireless/GPS activated points situated in key positions of important buildings. Contact with any of these hotspots activates a virtual learning experience as a tutorial, virtual tour or minigame.

The third gaming mode is based on a '*Universality versus diversity'* perspective. It is personified by the local inquisitor who has to adopt an analytical role focusing on existing administrative and legal structures. Going through historical events simulated in the game one has to reflect about the universal social, political, economical and religious rules that were followed in different countries at that time. At the same time one has to identify how these rules were adapted for the local situation and which ones were specific to Malta. The mission of the inquisitor will be a legal one, having to convince the grandmaster and other influential figures (the bishop, the knights hospitaliers, the architect and business men) to apply broad universal principles related to their respective fields and even develop new solutions to address local needs. For example, the user will earn more points if the design of new hospital to be built for the city and the administrative model for the health services is done differently from those of other kingdoms of the time (Italia, Spain, France etc.). The ambient component will include virtual tours and simulations of how buildings constructed by the Knights compared with similar structures developed in other countries. Preset links in virtual simulations like Google Earth can be used to compare specific structures such as military installations, like Valletta bastions, to other relevant structures in other countries. The underlying military principles could be compared and contrasted having direct on site experience. This comparative analysis can be done also along the religious dimension (exploring hierarchy, regulations and popular expression of the local Roman catholic religion) and business organisation (key figures, policies and regulations).

The fourth gaming mode, personified by grandmaster La Vallette, makes user adopt a political/managerial role controlling concurrently different factors and sub-systems. As the highest political figure of the Knights of Malta, the gamer has to analyse the evolving game from a systems perspective. The on-site gaming possibilities are used as a platform to promote reflection about the general political, religious, military, health and urban planning systems. The ambient interactive component of the game also presents information in a systems approach, showing for example how one building has a functional relationship with other buildings and with other sub-systems. The multiplayer aspect coordinates players' movements according to this system approach. For example each player's position is described by specific tools in the game interface in relation to the geographical orientation, city's street system, administrative system, system of fortifications, system of churches and that of leisure and recreational facilities.

4. CONCLUSION

This concise description of designing domain content for a game from an interactions perspective manifests the different pedagogical strategy employed. Game users are put in a position to experience domain knowledge and skills, not solely through symbolic representations and re-presentations characterising instructional contexts, but through a more holistic way by integrating simulation with real life immersion. Thus in the case of serious / educational games the main driving principle will be acquisition of identified domain knowledge and skills most commonly simulated in user gaming roles. Consequently the design task demands the ability to synchronise the interactional levels along the technology and community dimension as dictated by the interactions identified by the domain dimension.

From an interactions perspective, the process of designing mobile-ambient games can be summarised by the four stage process:

1. Conceptual design: Determine learning outcomes considering levels of interaction with domain (facts, concepts, principles, attitudes etc.).
2. Structural design: Organise identified interactions around domain core themes.
3. Metaphorical design: Personify these into game characters representing the gaming roles to be adopted by user
4. Navigational design: Determine mode of user interaction with game interface while playing default gaming roles. Identify and develop tools that mediate interaction between (a) game and external environment, (b) players (including geo-positioning, communication, knowledge sharing and reflection tools).

The importance of adopting an interactions-based design approach lies in the fact that domain knowledge can be categorised and itemised in a way that it can be captured by analytic systems such as pedagogic agents. Knowledge represented and stored as interactive items can be captured, analysed and manipulated by adaptive systems. This approach can also be applied to user interactions with the digital tools where one can quantify, categorise and record interactions with gaming console, game interface and with ambient interactive points. Along the community dimension interactions between multi-players or user interactions with gaming or domain experts can be quantified according to the type (Eg. Ask – for acquiring competence; Report – for sharing competence; and Comment – for reflecting on competence and performance) and directionality (Eg. User > user; user > users; users > user; user > experts; users > expert; user experts etc.)

This approach based on interactive elements is versatile when applied to any form of technology-enhanced learning. It integrates the different stages of the design process from prescriptive stages, through the evolving experience during the implementation stage to the final evaluative phase. The learning experience can be described through interactions profiles that include the type, frequency and directionality of interactions shown throughout the learning activity. The evolving learning experience can also be analysed through comparison of interaction profiles at different stages of the learning or gaming activity.

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Using Personal Digital Assistants (PDAs) in Healthcare Settings

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Abstract
This paper reviews the potential of learning resources provided in PDAs and investigates the ways in which clinical learning within two comparative institutions can be supported by using small handheld computers.

Keywords
Clinical learning, Personal Digital Assistants (PDAs),

1. INTRODUCTION
New technologies, especially mobile devices, are now emerging as tools that can provide seamless learning across different contexts, e.g. in the hospital, in the classroom and at home. Healthcare and medical education is a key work based learning context where mobile technologies have been widely embraced as learning tools. PDAs are used by many healthcare practitioners, particularly in North America. Many reports on PDA use can be found in the medical informatics literature, although the focus is not always on their use as learning tools (e.g., Lindquist et al., 2008, Garrison, et al 2003, Peters, et al, 2003, Lee, 2006, Barrett, et al, 2004; see also Walton, et al, 2005).

Recent studies in this area have shown that mobile technologies can provide additional opportunities to practitioners, especially in specific contexts and niche activities. It is also proposed that these technologies may support learner centred and innovative approaches to learning and teaching. Linquist et al (2008) in particular highlight the need for further action research into the development of appropriate functions and software for PDAs in a learning context. Although PDAs are not suitable for everyone, (for example, due to difficulties in manipulating for disabled users and small screen size) they can bring opportunities for learning in to any environment including commuting to work and anywhere that they will be taken. Having access to such a hypermedia environment allows users freedom to follow their activities in different environments they encounter and enables bridging of these activities.

When providing mobile learning opportunities in healthcare settings 'the situated nature of the activity' can be taken into account as one of the guiding principles. Mobile devices can provide learning whenever they needed, in the form required by the users and suitable to the context it is sought from. Kukulska-Hulme and Traxler (2007) maintain that mobile technologies can support diverse teaching and learning styles, and lend themselves particularly well to personalised, situated, authentic and informal learning. In the current study, the availability of the PDA and associated resources provided an opportunity where healthcare professionals could actively use their work place as a learning environment. This directly supported the transfer of knowledge and skills and encouraged specific application of general principles.

This study therefore seeks to review the potential of learning resources provided in PDAs linked to VLEs (Virtual Learning Environments) and to investigate the ways in which clinical learning within two comparative institutions can be supported by using small handheld computers also called personal digital assistants (PDAs).

These compact and portable devices can contain and organise a vast amount of information that can be accessed any time anywhere and at the point of care. PDAs and similar devices have become a valuable tool for clinicians and educators as they facilitate certain tasks such as getting immediate access to relevant clinical facts (for example checking for drug interaction, calculating important parameters) or expanding the differential diagnosis (Torre and Wright, 2003). These devices appear to be a cure-all for clinicians to cope with the amount of medical information confronting physicians every day. On the other hand, we still need to know how PDAs have been used and evaluated in patient care and medical education. Therefore this study will contribute to the research on the use of PDAs in clinical practice and medical education.

We specifically aimed to find out possible benefits and barriers from using PDAs for clinical learning within a variety of different contexts. This should support a deeper understanding of practice based learning increasing productivity, improving communication, providing immediate assistance, supporting evidence based medicine. None of the data collected relates to the specific patients or hospital practices. The project primarily concentrates on clinical learning processes through transferring learning materials into PDA within two comparative organisations.

2. CASE STUDIES
Case study 1:

The first case study is in the context of teaching of general surgery within a Turkish teaching hospital for specialists, doing their clinical practice in the hospital environment. The objective of the activity was to help participants make use of knowledge gained during their medical training in their clinical practice. PDAs were distributed to the participants as learning tools to support their learning and interaction by allowing access to learning materials related with their clinical practice. There were three participants in this case study.

Case study 2:
The second case study deals with the teaching of an ehealth course for 1st year students starting a health informatics course of study in the UK. This case study investigated the effectiveness of mobile learning in terms of teaching and learning experience by using PDAs as learning tools in an ehealth context for clinical and non-clinical students. The course, presented by the Centre for Health Informatics in Multiprofessional Education (CHIME) in University College London, is a requisite part of the Health Informatics curriculum. The objectives of the course are to prepare students to be part of an online learning community; to encourage them to reflect upon and practice their study skills and apply the skills and knowledge gained during the course to their workplace; to orient them to the literature and other resources to support their ongoing learning.

PDAs were made available to a selection of volunteer students as supplementary tools to support their learning and interaction by allowing access to learning materials related to the course. These materials can already be accessed through the UCL VLE so participation in this project provided only supplementary access rather than changing their learning resource access rights. The project recruited 6 participants for the second case study.

Each case study comprised a selection of comparative factors to allow for generic issues across these factors to emerge. Case Study 1 focuses on students later on their learning pathway in a specialism. Case Study 2 focuses on students early on their learning pathway in a far more general course on ehealth.

2.1 The Device

This PDA is a combined pocket PC and telephone using wi-fi and Bluetooth technology and also serves as a camera, mp3 player, GPS navigation system and a voice recorder. It uses numerous communication technologies so it can deliver information such as e-mail and calendar details when used with an appropriate mail server and software such as Outlook. Students taking part in the study were also provided with a 2 GB memory card for extra capacity and to provide course resources.

Figure 1. The PDAs used in the study.

2.2 The Study

Resources: Resources available for both courses included a large amount of text, recorded videos, images, photograph, audio interviews, and internet resources. The activities were designed to allow participants to use their PDAs in a variety of ways to support their course based/clinical based learning (see Figure 2).

The resources for CHIME students included all the course materials they have on their course web site including web links and library access. Course materials were presented in different formats but PDAs were able to present all the course materials correctly (Figure 3).

Figure 2. Resources on varicose veins that were provided on PDA for Case Study 1 participants.

PDAs were distributed to the volunteer students with details on how to use the devices and how to complete the project feedback on their activities. The quick guide to ‘How to use the PDA’, separate from the guides that were included with the device contained tips and advice to start using the PDA to access course resources and recording facilities included in the device. It consisted of information on:

- Setting up the PDA
- Familiarisation exercises (Opening and reading from a .pdf file, Listening to an audio file, Watching a video, Making an audio recording, Using the PDA to take notes, Creating anew note, Creating a new word document)
- Accessing course resources from the PDA
- Hints and tips (on Closing open applications, Copying files from desktop PC to PDA, Using GPRS, Using wifi)

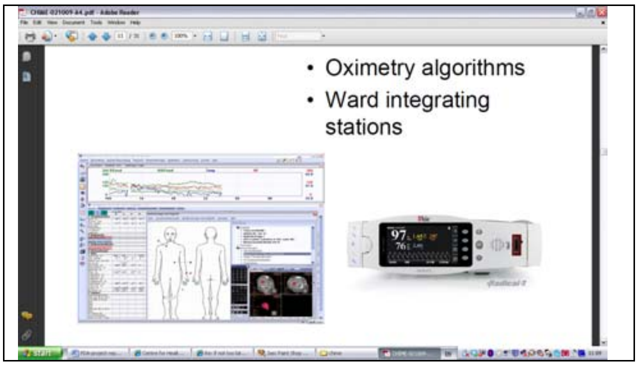

Figure 3. An example of resources provided for CHIME participants (Case study 2).

2.3 Implementation

Method: Students were asked to access the PDA resource or web-based resources and send us emails about where they where when they accessed the resources and a sentence or two on what they felt about this type of access. Email reminders were sent to participants to support their access of the resources and recording activities. Return of these accounts (preferably by email) was completed once a week for two months and only took a few minutes to complete. At the beginning and end of the project an online questionnaire was used to ask the participants to review their usage of the mobile devices for access to their learning materials.

During the course of their training, UK participants provided data with weekly emails and an end-of-project focus group; Turkey participants provided data with a couple of telephone contacts and an interview and all Turkish participants were interviewed face to face at the end of the project.

Participants: Turkish participants were all doctors working in hospitals; a professor in general surgery, a junior doctor in general surgery and a clinical fellow in anaesthesia.

UK participants were volunteers from UCL's CHIME course for NHS personnel. The UCL programme is designed around a range of learning pathways to meet the needs of students from various backgrounds and with various learning objectives. The sample for the present study contained: Clinical governance pharmacist, 2 NHS trainee managers, Senior information analyst, Health Information Lead, and Patient information officer.

2.4 Findings

The general findings of the study can be summarised as follows:

- Devices were used both as a learning device to help participants with their course materials and also as an organiser for their personal and professional life. During face to face interviews Turkish participants shared contents of their devices with the interviewer that contained their diaries, photos (both personal and professional), music, their .pdf files for teaching and learning.
- Participants synchronized the PDA with their PCs and found this invaluable, particularly for storing and reading emails, and keeping calendar and contact details.
- Participants used the devices to 'bridge' the different contexts of their learning environment (home, work) and also their personal environment. It was not used as the main medium of learning but when other opportunities were not available the portable devices provided means to keep up with study or work tasks:

Participant UK: *Today the new topics came up on Moodle. I had to take the bus to work this morning, so I checked the new topic on my PDA, I didn't do any work on it, as the bus was noisy, but I was able to familiarise myself with this weeks topic and then go through it fully on my laptop when I got home.*

- For most of the participants it was difficult and slow to connect to the Internet via the PDA.
- For one of the Turkish participants it was important to get medical reference information in the PDA' when and where they require'. He suggested, for example, a Drug reference book Vademecum would be extremely useful for that purpose. But he did not know if it was available as an e-book.
- Battery life limitations were a problem for some participants in both contexts. Especially for participants in Turkey, as practicing doctors, it was important to be able to get all calls when they were 'on call'. When the battery in the PDA went flat in the middle of the day it created problems for users.
- There were some unexpected uses of the PDAs when other means of accessing the learning resources were not available:

Participant UK: *So far, I have found it most convenient how quick and easy it is to transfer files to and from the PDA - when I am in a rush and haven't got time to finish reading a web page, for example, I just plug in the device, save the page and drag it across.*

- Two of the UK participants compared and found that some features of the PDA were better than iPhone (use of stylus to write, ease of working with Microsoft documents) and Blackberry (screen):

Participant UK: *Once able to read the PDFs, the screen was clear and larger than my own BlackBerry so made it easier to read documents.*

- Learning potential of such a device was recognized by participants in both countries.
- The PDAS were found to be a little outdated – big and not always synching with new operating systems.
- The camera was not found to be good quality by one of the users in Turkey.

Participant TR: *I was going to take a picture of varicose veins on a patient when visiting a hospital, but when offered the proper hospital camera by my colleague I accepted because it would be a much better picture from that camera.*

It is clear from these findings that health care professionals expect PDAs and similar devices to become increasingly useful. Healthcare institutions can help their employers by providing ready to use applications such as drug formularies, reference databases and schedule information. This study also showed that any support and training provided by the institution would help employers to use technology to increase efficiency. This was mainly true for Turkish participants as in the Uk technology and the applications are more 'PDA-friendly'.

3. CONCLUSION

Many studies in this area mention low use as one of the findings of clinical based PDA use. There are several reasons for this finding. One of them is the personal nature of the PDAs and similar devices. Users all have different expectations from their mobile device. If the device is provided in the context of a project, it is selected by someone else. Getting used to a device provided to you takes time. Another reason might be the fast pace of life in clinical settings and when there are better ways of communication, e.g. face to face, this is preferred. In addition, in the beginning a PDA may look like a complex and confusing technology to users who are not very experienced with technology. For that reason providing the right support and relevant applications and resources in the devices is essential.

However there are many areas where PDAs provide valuable functions for doctors and other clinical personnel and this study showed that with the correct approach and technology, real benefits in terms of accessing resources and synchronising planning and personal information can be achieved. One of the advantages of PDA is the speedy access to required knowledge and an opportunity to check for the latest medical information in a convenient way. Access to drug and medical information as mentioned some of the participants in this study may improve patient care and will make it more efficient and time saving.

As mentioned by Turner et al (2005) "junior doctors are currently expected to carry with them at all times unwieldy reference volumes and a Dictaphone, all of which could be replaced with a single PDA." (Turner, Milne, Kubitscheck, Penman & Turner, 2005; p.216) and they aim to address in their future work to focus on meeting junior doctors' information access needs with PDAs. The current project echoes the findings from Turner et al study and we agree that reference information in PDAs is a very accessible aim that would make life much easier for junior doctors.

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Mobile learning for HIV/AIDS health care workers' training in resource-limited settings

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Abstract

This is a joint project from the Institute of Tropical Medicine in Antwerp, Belgium and the Institute of Tropical Medicine Alexander von Humboldt, Lima, Peru. We hereby present a mobile learning approach for health care workers' (HCWs) training using mobile phones as personal learning environments. Individual smartphones (Nokia N95 and iPhone) equipped with a portable solar charger were used by 20 physicians deployed in urban peripheral HIV/AIDS clinics in Peru, where almost 70% of the national HIV-patients in need, are on treatment. Learning activities based on learning theories and mobile functionality were embedded in the mobile project to enhance learning. Clinical modules were offered to the HCWs. A set of 3D learning scenarios simulating interactive clinical cases were developed and adapted to the smartphones for a continuing medical education program lasting 3 months. A mobile educational platform supporting learning events, could track participants' learning progresses over time. A discussion forum accessible via mobile could connect the participants to a group of HIV specialists available for the back-up of the medical information. Learning outcomes were verified through mobile quizzes using multiple choice questions at end of each module. In December 2009 a mid-term evaluation has been delivered looking at both technical feasibility and user's satisfaction, highlighting the technical challenges encountered using mobile devices for lifelong learning and the users' perception of the program. The challenges met during the project gave rise to discussions and future directions for research.

Keywords

mobile, HIV/AIDS, mobile learning, mLearning, health care workers, low resource settings.

1. INTRODUCTION

In order to enable HCWs involved in HIV/AIDS care in urban peripheral stations in Peru to access the state-of-the-art in HIV treatment and care, the Institute of Tropical Medicine Antwerp (ITMA) in Belgium and Institute of Tropical Medicine Alexander von Humboldt in Lima (ITMAvH) in Peru set up an educational mobile application in 2009, allowing knowledge sharing and data contribution through a mobile-based educational platform.

This paper gives an overview of the pedagogical approaches used in the project, as well as the technical methods and materials in an attempt to combine those two

2. PROBLEM

Health care workers (HCWs) have indicated the need for an autonomous mobile solution that would enable access to the latest medical information for continuing professional development using low cost devices and to exchange ideas about difficult clinical cases with peers through social media (Lindquist, Johansson, Petersson, Saveman & Nilsson, 2008 and Jham, Duraes, Strassler, & Sensi, 2008).

3. BACKGROUND

Looking at mobile learning in a wider context, we recognize that mobile, personal, and wireless devices are now radically transforming societal notions of discourse and knowledge, and are responsible for new forms of employment, language, commerce, as well as learning (Ally, 2009). The arrival of mobile and wireless technologies is also rapidly changing the access in low resource areas, where the mobile phone is set to play a major role in the stimulation of the information society in developing countries (Ford & Leinonen, 2006).

Mobile technologies fulfill the basic requirements needed to support contextual, life-long learning by virtue of its being highly portable, unobtrusive, and adaptable to the context of learning and the learners' evolving skills and knowledge (Sharples, 2000). Building on those two definitions Vavoula and Sharples (2002) suggested that there are three ways in which learning can be considered mobile: learning is mobile (1) in terms of space; (2) in different areas of life; and (3) with respect to time. These definitions suggest that mobile learning systems should be capable of delivering educational content to learners anytime and anywhere they need it. It is exactly this flexibility that fits the HCWs setting, for they need to be on the move most of the time, making both house calls and traveling to neighboring clinics.

4. PEDAGOGICAL APPROACH

While a more in-depth description of the used materials will be given later in the paper, an overall view of pedagogical approaches linked to the offered mobile content is given here.

3.1. Personal, authentic and contextualized content

Mayes and de Freitas (2007) noted that "underlying both the situated learning and constructivist perspectives is the assumption that learning must be personally meaningful, and that this has very little to do with the informational characteristics of a learning environment" (p. 18). By delivering mobile content that was of immediate relevance to the HCWs professional demands, the delivered materials motivated the HCWs to go through them.

The content of the different clinical modules for this mobile project was based on actual real life examples, adding to the authenticity of the learning material. Helen Beetham (2007) wrote clearly on the authenticity of the activity: "Apprenticeship and work-based learning depend on activities arising 'naturally' from a highly authentic context (situative learning)" (p. 27).

We wanted to build further on this by adding the possibility for the learners themselves to exchange cases through their mobile. By allowing content to be put forward by the learners via Facebook, skype or the discussion forums, it contextualized the case studies that were exchanged between all the learners. For as Sharpe and Oliver (2007) wrote "practitioners continue to favour interventions that are contextualized for them;… allow practitioners to work on their own real-life issues; and take account of the language, values, culture and priorities of their particular community" (p. 123). The fact that this case study gave the students the possibility to link the content to an environment that was relevant to them increased the chances of enhancing their learning process.

3.2. Problem based learning and peer-to-peer exchange

The cases put forward to the learners pushed them into solving real life examples that were relevant to their professional setting. Problem based learning is becoming increasingly important as it fits the constructivist learning theory model and enables a more thorough understanding of the content that is discussed. The problem based learning was learner-centered as the HCWs were asked to put their own cases up to be discussed with their peer learners by using the mix of mobile tools that were offered to them.

Peer-to-peer knowledge exchange is an extra asset to mLearning, which is promoted by the affordance of mobile devices, as one of their primary functions is communication. Communication through mobile phones has a low threshold for learners, which makes it an easy peer-to-peer exchange tool, but with smartphones an added communication channel could be added: social mobile media. Peer-to-peer knowledge exchange was one of the overall logic to obtain the learning objectives, as this enables the learners to build on their own experience and knowledge. This peer-to-peer dynamic was made possible by using different social media software's (Facebook, skype), but also the discussion forums inside the mobile Moodle learning platform.

The use of Facebook enabled a swift exchange of ideas. A Reach learner group was built inside Facebook. Skype was used to enhance peer-to-peer phone discussions and learner-tutor communication.

3.3. Attention to diversity in content imagery

Sharpe and Oliver (2007) pointed out that "Activity, motivation and learning are all related to a need for a positive sense of identity, shaped by social forces" (p. 18). Taking this into account the mobile animations and scripts offered in the course were screened to offer a more diverse imagery in the course. Mobile courses have grown in the past few years. Research has pointed out that context and identity are important motivational factors in mobile learning (Sharples, 2006). Gender and ethnicity are part of both context and identity of the learner.

The social cognitive perspective in teaching and learning emphasizes the importance that social interaction plays in contributing to motivational outcomes such as learner self-efficacy and self-regulation. According to Bandura (1997), attribute similarities between a social model and a learner, such as gender, ethnicity, and competency, often have predictive significance for the learner's efficacy beliefs and achievements (Bayler & Kim , 2004).

Interactive multimedia instructional design is anchored in culture through various world views, selective instructional design paradigms, and learning theories. As such, it is culturally contextualized (Henderson, 1996). Having proactive instructional design is particularly significant for learners who belong to cultures that are situated in an unequal relationship (Henderson, 1996). In order to be inclusive, a balanced presentation of diverse human groups is required, for example men and women, people with different ethnic and cultural backgrounds or religions, etc. (de Waard & Zolfo, 2008). The same argument is made with respect to digital educational materials. Analyses, however, show that such a balanced representation is not always provided (Heemskerk, Brink, Volman & ten Dam, 2005)

In the animations that were used for the clinical modules on the mobile devices, a balanced ethnic and cultural mix was taken into account, with the goal to address a more varied learner audience, that would as such feel that the content appeals to their identity.

The above paragraph shows how the learning activities that were put into the course had pedagogical relevance, as well as technological affordances. Now let's go into detail and look at all the specific parts of the course connected to the mobile devices that were used.

5. TECHNICAL MATERIALS & METHODS

Out of 24 Peruvian Department Capitals, 20 were already involved with the Institute Y in a distance learning project, which started in 2004 having as aim the scaling up access to antiretroviral treatment in the Peruvian peripheral regions. These 20 facilities were included in the mLearning pilot project. The health centres in the Department Capitals are run by medical doctors and staffed with 5-10 health care workers as social workers, counsellors, and data clerks. Individual Smartphone's (10 Nokia N95 and 10 iPhone) equipped with a portable solar charger were delivered to the 20 physicians based in the peripheral HIV centres.

A router connected to a DSL or cable modem, available in all stations, allowed wireless connection, facilitating the surfing and the download of the didactic material in any place of the clinic, guaranteeing at same time wire-free interactions, without the need of participants to purchase a complete computer to connect and reducing the cost of communications, using Skype via mobiles (Figure 1).

Figure 1: Smartphones: Nokia N95 and iPhone

The training program was composed by a set of 'clinical modules' simulating interactive clinical cases which were adapted to mobile devices and sent to the physicians working in the 20 Peruvian HIV peripheral clinical stations. The whole case series involved 5 different topic areas, the most common being the use of new drugs for HIV/AIDS treatment, their safety and side effect profile; the mLearning program was delivered during the months November 2009-January 2010.

Figure 2: Example of 3D animation

The didactic material was developed with 3D animations using iClone and Moviestorm, reproducing specific scenarios (e.g., clinical consultation) (Figure 2) and each module revision was provided through multimedia files (developed with screenflow which enables starting from power points to add to the screen shots audio and video, publishing everything in a mobile accessible format).

Learning outcomes of the acquired knowledge were tested through mobile-based multiple choice questions issued at beginning and at end of each module (Figure 3).

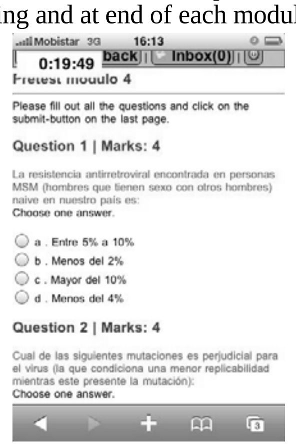

Figure 3: Example of a post-test

A functional mobile platform (MLE Moodle) was offered to support the learning events, tracking students' progresses over time. The platform also provided access to Facebook for peer-to-peer learning sharing on clinical cases discussion within a network of experts, which assured feedback content quality. The suggested readings were distributed along the timeframe of the 2-week clinical module discussion mainly as Pdf format, using Google docs (Figure 4).

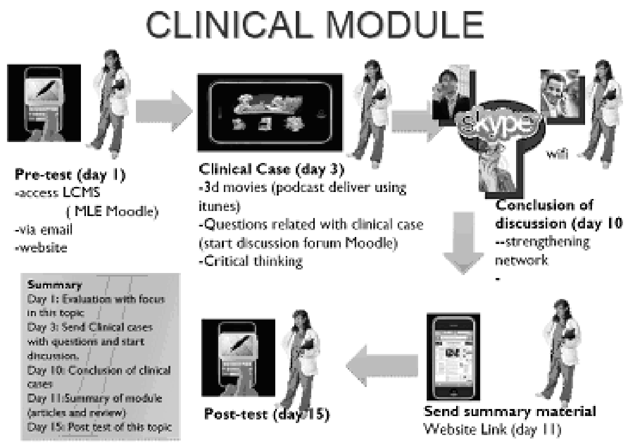

Figure 4: Clinical module: flow

6. LEARNER EXPERIENCE RESULTS

A mid-term users' satisfaction survey delivered through a standardized anonymous questionnaire, coupled by a focus group discussion, was performed in December 2009.

The users' satisfaction surveys sought to gain feedback on quality of the tutorials, usefulness of the information, applicability to the daily context of HIV treatment and care; the focus group discussion sought to identify general barriers to the program adherence; the help desk interview gave information about the technical difficulties encountered in implementing the program.

Out of 20 participants, 18 returned the standardized questionnaires (response rate of 90%); the participants' median age was 48,5 years (range, 34 - 55 years), with a median of 6 years experience in treating HIV patients. Most of the participants had no prior mobile learning experience and their social media literacy was also limited (Figure 5).

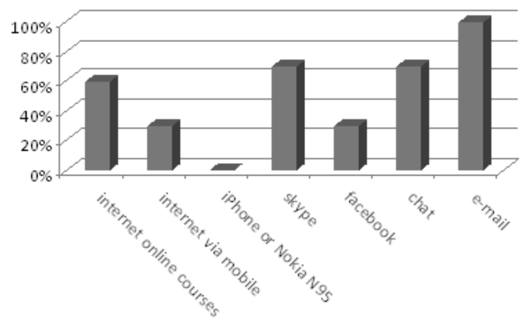

Figure 5: Participants' previous computer use

Over half of the iPhone users, 66,67%, indicated that Skype was easy to access compared to the 22,2% using the Nokia N95; 88,9% of the iPhone respondents found easy to access Facebook via mobile compared to the 44,4% using Nokia N95. The results indicated similar usability of iPhone and Nokia N95 (88,9% and 87,5% respectively) for the download of podcasts and access to MLE Moodle for pre- and post-test.

The freedom of planning the educational activities according to the user' personal agenda was indicated as an added value by 86,6 % of the participants; the access to the educational content without needing a computer, by 94,4%. All respondents had positive opinions about the quality of the received information, the applicability of the content to the clinical practice and the appropriate relevance of the suggested readings.

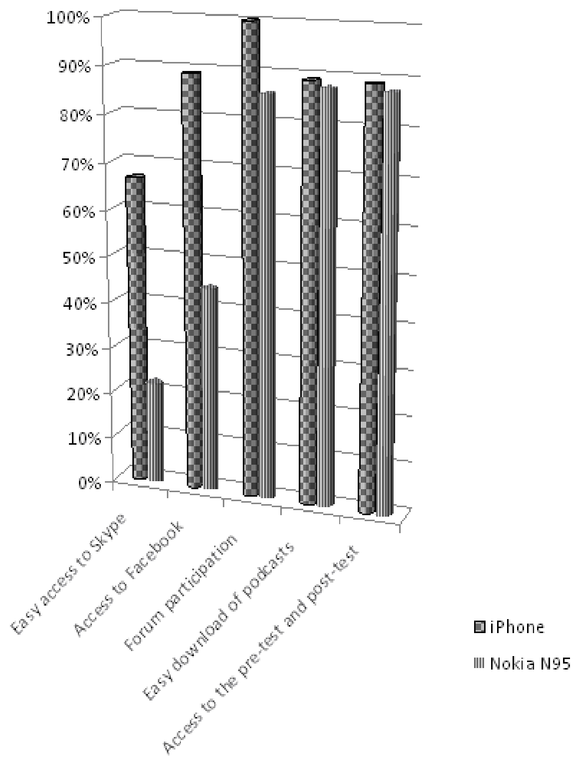

Figure 6: Use of applications according to mobile device

The main advantages indicated by the participants during the focus group discussion were the portability of the equipment and easy access to the educational content at own space and time. Some of the Nokia N95 users pointed as problematic the screen size of the equipment, the keyboard size and the quality of the images. The topics covered by the program have been graded as pertinent to the daily clinical practice and very well thought by the participants.

7. DISCUSSION AND FUTURE RESEARCH

7.1. Peer learning in access challenged regions

Many developing countries would move towards the use of distance learning programs avoiding peripheral health stations being left unmanned, because of HCWs moving out for short or long training programs (Lester & Karanja, 2008). As Peru is a developing country, there is limited access to information and teaching resources and a great need to enhance learning and teaching environments: mobile phones can create an inexpensive, reliable, learning environment between health care workers in a 'one-to-one personal learning' and between colleagues in a network. Some of the mobile devices are relatively low-cost, powerful, small and lightweight, and they can well perform in difficult environments because of very little power required for the internal battery, which can be recharged using inexpensive solar panels (Kneebone, Bello, Nestel, Mooney, Codling, Yadollahi, Tierney, Wilcockson, & Darzi, 2008).

However, by using smartphones (with solar panels) as a means to keep peers up-to-date on the latest medical education, there is a risk that less financially strong HCWs will not have access to this means of learning due to the cost of the hardware. This might result in an extra digital divide.

7.2 Time investment challenge

Although mLearning is applauded for its capacity to offer learning where no learning could take place before, the time investment necessary to allow the learners to truly dedicate themselves to the provided courses or materials is often overlooked. This was also the case in this project. The HCWs participating in this project were not given extra time to dedicate themselves to the training workload. The learning came on top of their work. Although learners were willing to go all the way with this project, one can doubt the long-term feasibility of mLearning that will always be on top of the workload. For it is not because mLearning can be done at anytime, anyplace and anywhere, that this implies that no extra time should be made available.

7.3. Enhancing mobile tech literacy

HCWs can learn how to use mobile devices, how to search for information, how to upload and download information in a relatively short time frame, i.e. one day of intense training and a helpdesk available if needed. The use of Smartphones enables users to upload and download information using the wireless capacity. The Smartphone can be very useful in distance learning giving to the users the opportunity to contact their mentor by phone, receiving immediately feedback and helping to establish a network (Krishna, Boren & Balas, 2009 and Prgomet, Georgiou & Westbrook, 2009).

The unique future of this project is that the skills the healthcare providers acquired with mobile technology are easily and effectively transferred to other areas of their lives (from acquired knowledge to computer literacy, with impact on digital divide) through the implementation of learning theories related and functional in a mobile learning environment.

Although the increased mobile literacy seems to be a good thing, the mobile literacy should be taught in such a way that it is generic no matter which future mobile devices will be used.

7.4. Age and digital literacy

An interesting fact of this project was that the average age of the participants was 48,5 years old. Looking back, it would have been interesting to see where the learners could be situated in Rogers' (1960) Technology curve to understand whether the success of the learning outcomes could (in part) be linked to a certain level of technological preference of the participants of this project. This can be done taken into account research done by Bristow (2009) on technology innovations as specific domains of interest comparing the concept with the basic characteristics of digital natives and immigrants.

7.5. Ethics of mobile devices

While providing the learner group with expensive smartphones, some ethical considerations came to mind: can research promote a specific mobile device and push it onto a population that has considerable financial limitations? How sustainable are projects that rely on expensive equipment in low resource areas? How does sharing patient information through mobile devices (camera's, open discussions) comply with patient privacy issues? Especially when taken into account the data dispersal of social media software (e.g. Facebook data)? The ethical aspect of any social media based mobile project reaches beyond the local context, but has global implications. Although we did discuss patient privacy, user consent, and we assured sustainability and follow-up, we were not taken into account all the ethical implications of a mobile project (Facebook, sharing information issues). Ethics in mLearning projects should be researched more extensively in the future to create a generic ethical framework for technology in learning.

8. CONCLUSION

With mobile devices the learning environment is enhanced and ability to share knowledge through online discussion is strengthened through social media or directly on phone line. The sharing of experiences in a network facilitates the transformation of learning outcomes into permanent and valuable knowledge assets.

The results show that the delivery of up-to-date modules on comprehensive treatment and care of people can be contextualized and customized to mobile devices. Particular attention should be given to the adaptation of the educational material to the small screen size, time restraints, local technological reality, ethics, and to the performance of the program development in the different operating systems.

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Technologies

Short Papers

Sustainable Mobile Learning: Open & Offline

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Abstract

The main aim of our research is to explore the use of Wikireader as a potential tool to provide an affordable and sustainable offline mobile learning solution. We will evaluate the usability of Wikireader and validate the concept of an offline mobile learning approach by conducting a pilot study in Thames Valley University, UK. In this paper, we try to understand the importance of considering an appropriate target mobile platform as a key aspect of a sustainable design to deliver and support learning. We also analyzed the data collected at the early stage of the pilot study and our result indicates a lack of high-end or 'smart-phones' among students and therefore supports our cost-effective approach to mobile learning.

Keywords

ICT4D, offline mobile learning, open-source, copyleft hardware, Btlogger, Wikireader.

1. BACKGROUND: MOBILE LEARNING

Mobile learning (M-learning) is a relatively new research area and it uses mobile technology to facilitate learning. It is a field whose practice has not yet been standardized in terms of research frameworks, methods and tools (Vavoula & Sharples 2009). Moreover, the learning material is often developed with proprietary specifications, preventing content from being shared and reused (Nakabayashi et al. 2007). Also, the consideration of usability principles for mobile Internet applications suggests that mobile learning solutions warrant a specific approach (Uther 2002).

Mobile education application models can be classified into three categories: 'permanently online', 'frequently online' and 'offline' and they bear their own advantages and disadvantages (Qian & Nan 2008). Authors identified applications of permanently online mobile education rely on the wireless network, and to most learners permanently online is hard to achieve and not necessary. They also suggested offline mobile learning with no interaction with servers is also not acceptable. But, one of the important challenges of broad areas for mobile computing is building applications that deal with the arbitrary disconnected nature of mobility, i.e. offline (Yang 2000).

Considering the difficulties and challenges of delivering a successful mobile learning, we propose an offline mobile learning solution (Shrestha et al. 2010) using the Wikireader[1]device to deliver learning. We plan to evaluate the usability of the Wikireader and validate the concept of an offline mobile learning approach by conducting a pilot study in Thames Valley University, UK.

Next, we will discuss the selection of a mobile platform by some of the recent pilots and projects and present the rationale for choosing the Wikireader device. Then, we will provide an insight into the trends of use of mobile devices in Thames Valley University, based on data collected using Btlogger[2] Bluetooth software and finally draw a conclusion by reflecting on our approach to mobile learning.

2. SELECTION OF DEVICE

Before proposing, developing and piloting a mobile learning solution, the importance of considering an appropriate target mobile platform to deliver and support learning is one of the key aspects of a sustainable design. However, mobile learning researchers are focusing on integrating expensive new smart mobile devices (such as iPhone and iPod Touch) into schools and universities and delivering learning resources to meet students' academic needs. But, building applications on these devices mean using the controlled proprietary platform that restricts development.

Most of the recent mobile learning pilots and projects generally relied on provided or loaned smart mobile devices to identify the usefulness of such technologies. An iPhone application such as iSanford (Pena 2009) from Standford University was developed to disseminate learning services and also by Curtin University of Technology, (Robinson et al. 2009), which has again utilized the iPhone and its subsequent operating system as their platform of choice (Crane & Benachour 2010).

As part of university initiative to encourage creative usage of technology in education and campus life, Duke distributed 20GB Apple iPod devices to over 1600 entering freshmen in August 2004 (Duke Digital Initiative 2004). In the fall of 2008, Abilene Christian University became the first university to distribute Apple iPhones and iPod Touches to incoming freshmen of the university, allowing people to explore a new vision for mobile learning (Li et al. 2010).

Similarly, to explore the viability and effectiveness of a mobile teaching and learning environment that would take advantage of mobile phone access to internet instructional materials, iPod touches were provided to students through the college fund (Tien & Boston 2010). To investigate how

[1] http://thewikireader.com/

[2] http://gitorious.org/btlogger/

best to use mobile technologies in learning and teaching, community of higher educators was formed and the project funded the purchase of iPod touches (Schuck et al. 2010). On the development of a mobile learning portal at University of East London (UEL), currently trails for evaluation are being planned by providing devices with WiFi capability to students through project funding (Olasoji & Draganova 2010).

Even though applications based on these smart devices may prove to be highly successful, with their choice of exclusive medium, do restrict the amount of penetration in a vast and varying mobile market (Crane & Benachour 2010). Also, from a developer perspective, developing solutions for a locked down device restricts creative and innovative development (Moore et al. 2009).

However, according to Traxler (2010), mobile learning approach centred on student devices is challenging and radical for institutional IT units. He also highlighted that from a methodological perspective, it is easier with a homogeneous and predictable technology platform and also easier from a staffing and infrastructure perspective since planning and training are comparatively straightforward. It does however mean that most mobile learning pilots and projects are unsustainable because they are predicated on finance in order to provide subsequent cohorts of students with devices (Traxler 2010). Thus, even though use of the latest mobile technologies can have significant impact on teaching and learning, assessment of the issue of cost in the long term is important to sustain the solutions.

Also, ownership of the technology is equally important in mobile learning. Corlett et al. (2005) found that whilst the PDAs were loaned, students were reluctant to invest time and money in personalization and extension. Similarly, from experiences in early pilots, Traxler (2010) suggested that students were not likely to value a second, university-provided device that did not express their taste or aspirations and that it would inevitably be the one left at home.

Some of the current studies also highlighted the issue of affordability, while students were required to pay for the service. StudyTXT (McGuigan et al. 2010) – a SMS based supplementary learning tool within an introductory accounting decision-making course was implemented in order to assist students who may like to download 'bite-size chunks' of information prior to the term test and final examination. The most conclusive reason for respondents' discouragement of StudyTXT's use was the perceived high cost associated and was a barrier to its widespread usage. Similarly, another study of using SMS to enhance students' learning experience in the course highlighted the issue of cost that may prevent both the instructor and students from further using it, especially if an interactive mode is adopted (Santos 2010).

There are also examples of mobile learning studies that have taken similar approach to deliver mobile learning in developing countries. In one of the recent pilot studies in Sri Lanka, a company (Dialog GSM) provided mobile phones to study the use of mobile phone cameras in science teaching and learning, due to schools not having adequate funds to acquire mobile phones for one-to-one use, (Ekanayake & Wishart 2010).

In Bangladesh, the 'English in Action' project at its initial phase aims to identify the effective, scalable and sustainable model of supported Open and Distance Learning for English Language Teachers, and the most appropriate forms of mobile technology to support this (Power & Shrestha 2010). As part of the project, currently teachers from rural schools are being provided iPods to use in the classroom. Such teachers often work in the most challenging situations, with large class sizes, grade repetition, extremely limited teaching resources, poor infrastructure and high exposure to seasonal or environmental strains. However, authors argue the current need to conduct this developmental research is to explore how such technologies can be used to support English language teaching in Bangladesh based on the forecast that mobile technologies will be widely available and affordable, capable of supporting language learning activities and practices, within the next 3 to 6 years.

There are however examples of recent projects in developing countries that throw considerable light on issues of sustainability and scale as the projects face challenges to extend their scope and their impact (Traxler & Leach 2006). Therefore, in the context of developing country, it is consideration of cost-effective alternative platforms to high end mobile devices is also important (Shrestha et al. 2010).

While benefit of mobile learning is clear, developing sustainable solution is still a challenge even in a developed country. One over-riding concern is the problem of moving projects and pilots into the mainstream of educational provision and finding secure and sustainable funding and support (Traxler & Leach 2006). Thus, use of an open platform that can support creativity and provide freedom and unlimited choices for developers may allow development of cost-effective solutions which will ultimately empower end-users with wider possibilities.

3. WIKIREADER

The Wikireader is a non-wired mobile device. The Wikireader software platform is open source and freely available. The software is loaded directly from the micro-SD card that stores the content as well. This US$99 handheld device stores the text enabling an offline access and an interface has been designed aiming to provide a simple navigation model.

Initially, it provides the content of Wikipedia (an electronic encyclopedia). But it allows the software developer to customise or adapt the software and contents as necessary. Most importantly, as these kinds of devices are very limited in functionalities, they may have minimal resale potential. We see this as positive since they would be more likely to be used for learning purposes rather than being stolen or sold. "One trick pony" devices can be a safe solution. Also, for the rural communities with limited ICT experience, a few interaction points on a device can reduce the time it takes for users to familiarise themselves with the device. But most importantly, this may reduce uncertainty.

The device has a reflective monochrome display, a scratch resistant tempered glass screen and strong plastic casing for added durability. These form factors are some of the rationales for opting for Wikireaders. It runs on two AAA batteries for 12 months in normal usage. Sustaining such cost should not be a hindrance compared to getting to and paying for Internet cafes.

Also, because the device is an open platform, it would be expected that the community of developers would influence its future hardware and software revisions and potentially increase distribution and thus reduce costs. In addition, Wikireader developers' open source community also provides technical support to all interested parties to build customized content for the devices.

4. PILOT STUDY

The project will be piloted with content from the Mobile Application Development module which is part of the MSc Network and Mobile Computing course. We will have a small group of full-time students taking this module and be part of our pilot study.

We initially surveyed the mobile usage of our postgraduate students. We collected information about their choice of phone, payment plans, and mobile internet usage including their personal usage of university’s virtual learning environment. Before undertaking the pilot study, we also wanted to investigate what devices are generally used in the university’s campus. Therefore, we used Btlogger to collect data from discoverable Bluetooth devices.

4.1 Students Survey

Our Masters programmes attract a large cohort of students from India. These students can have difficulties adapting to a UK university learning environment. They also have limited access to ICT resources outside the university.

We have sixteen students currently registered for the MSc Network and Mobile Computing course, who will participate in our pilot study. The age of participants varies from 18 to 25 years and all the students are male. They all have modest to high desktop computer experience and use internet everyday or almost everyday. Nine of the students have different range of Nokia phones from 1600, 2323c and 6303. Four students own Sony Ericsson phones, one has a Samsung and two of the students own iPhone. Out of sixteen, only three has contract and the rest are on ‘pay as you go’ including both iPhone users.

Out of sixteen, one has an average mobile using experience and fourteen students have a good experience. Eleven of these students have no experience of web browsing on mobile phones as well. Other five participants have limited mobile web browsing experience. All the students use their mobile phones mostly for making calls and text messaging.

When asked why they do not use mobile for web browsing, students are very concerned about the cost. Some of them also have devices that do not support web browsing and some do not need to use mobile phone for browsing as desktop use is sufficient for them. None of the students have ever seen or used Wikireader before. However, they have all said it will be beneficial to provide uninterrupted access to learning materials using Wikireader while avoiding the need for Internet access via mobile phones

4.2 Btlogger

Btlogger is an open-source and simple Bluetooth to Sqlite logger software than can also post results to Twitter. The tweeting feature helped us monitor an overall data collection process and also allowed us to share the results live as we want to be as open as possible. An important feature of this software is, when it discovers the previously found devices, it updates the same device in the database and avoids any duplication of data. The software works on any Linux system with Bluetooth.

In our study, Btlogger logged a total 1295 discoverable Bluetooth devices over 8 months between 7th September 2009 and 10th May 2010 in the University’s Ealing Campus. Usually Bluetooth broadcast is disabled by default on mobile devices and this software relies on only those devices with Bluetooth on. Also, due to users personalizing the default name of the devices, manufacturer details of 54% of the logged devices could not be recognized. However, the remaining 46% of the logged devices gave us a useful indicator to the current trend of mobile use in our university campus which is presented here.

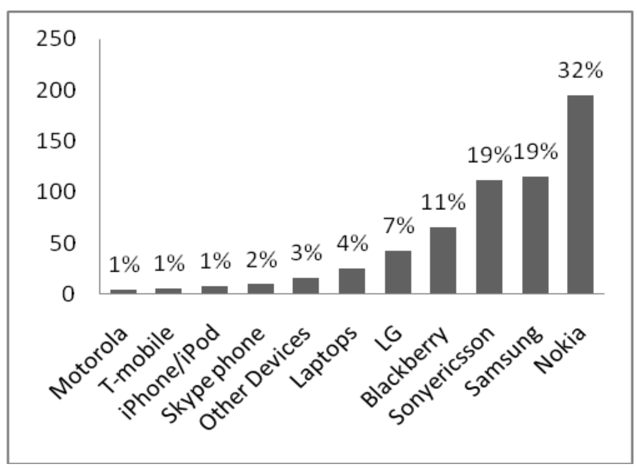

Figure 1: The penetration of mobile devices on Thames Valley University’s Ealing campus

The graph shows (see Figure 1) 32% of devices have been Nokia devices, about 19% of Samsung and Sony Ericsson, and 7% of LG devices and 11% Blackberry. With only 1% of the iPhone/iPod share, it shows only a small percentage potentially use such smart devices in our university. Similar previous research study (Larsen et al 2004) within the

Lancaster University campus also showed the lack of high-end or smart-phones penetration.

With a diverse range of devices available which correspond with the mobile user's needs and budgets; creating a solution which works successfully for a range of different manufacturers and models would be difficult (Crane & Benachour 2010). Also, even though the low-end phones are stable and widely available, they are not capable of supporting smart learning applications.

5. CONCLUSION

With the lack of high-end or 'smart-phones' in the investigation, our findings highlight the difficulty of developing a sustainable mobile learning solution in our university. Therefore, our research focuses on developing systems for more cost-effective (under US$100) open platforms that support customized content for learning purpose.

At this stage, it is not possible to predict in advance how the students in our University will use the unconnected Wikireader devices with limited functionality that do not offer an interactive or media-rich learning experience or even if they would adopt them at all. Our ultimate goal is to develop a successful solution, a service that users really need by improving the technology, supporting learning and providing a satisfactory user experience at the same time.

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More notspots than hotspots: strategies for undertaking networked learning in the real world

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Abstract

Much of the mobile learning literature implies that connectivity between devices can be taken for granted. This is not clearly not true with patchy network coverage and variable signal strength even in well developed urban areas. In this paper, we describe strategies devised for overcoming the challenges of variable connectivity quality to ensure mobile learning in authentic field locations and also bridging contexts (home, school, work). We consider three approaches: the use of Wi-Fi, 3G phone networks, and working locally with post-activity synchronisation. We conclude with recommendations for practitioners and researchers.

Keywords

Networking, Connectivity, Wi-Fi, 3G, Schools, Fieldwork.

1. INTRODUCTION

Mobile learning is often built on the assumption that the underlying technologies "…'afford' real-time information whenever and wherever learners need it" (Luo et al., 2010). This draws from Mark Weisners's vision of Ubiquitous Computing (1994) and the idea of tools that don't intrude on the users' consciousness, but let them focus on the task rather than the tools themselves. In networked learning, therefore, this includes the ability to connect to remote services, resources and users whenever and wherever the learner desires.

However, away from the research laboratory the reality is that networks are more likely to be characterised by patchy network coverage, fluctuating signal strength, deviations in positioning and variable data rates (Broll, Benford and Oppermann, 2006; Girardin et al., 2008) leading to poor quality service and variable levels of reliability. In urban areas, 'shadowing effects' can limit the quality of Wi-Fi and phone coverage, and 'urban canyons' of high buildings can affect the accuracy of GPS dependent devices. In rural areas, network coverage can be low to non-existent; for example Scotland has better 3G mobile phone coverage in the seas around the mainland (by area) than on the mainland itself[1]. It could be said there are more 'notspots' than radio 'hotspots' when supporting mobile learning in the real world.

Undertaking mobile learning in authentic environments therefore requires practitioners and researchers to explore a range of networking strategies. In this paper we describe our experiences in the TEL-TLRP funded Personal Inquiry (PI) project in the UK (www.pi-project.ac.uk). We have carried out seven trials over three years with 300 students (aged 12-15 years) and seven teachers, supporting inquiry-based learning that bridges different environments including a fieldwork component. We describe a range of strategies that we have employed to enable technology enhanced learning with mobile devices to be successfully carried out while moving between contexts (school, home, field sites). Using Asus Eee PC netbooks as the central computing device, we have taken three networking approaches: Wi-Fi, 3G phone networks, and local only (non-networked) with post-activity synchronisation. We will describe how each of these approaches has been applied in trials and summarise our learning outcomes and recommendations for other researchers and practitioners.

2. THE PROBLEM

We have developed the web based nQuire toolkit, a software tool that can be configured by researchers or teachers to provide a learning environment that helps students to plan and undertake their investigation (www.nquire.org.uk). Access to this tool throughout the investigation is essential for successful completion of the work. The key problem, therefore, was to find a means of achieving connectivity to the central server during their investigations in different settings: at school, at field locations, and at home and other unknown locations outside formal educational contexts.

Investigations were led by a teacher and undertaken by a number of students, working either individually, in groups, or as a class, and often moving between these groupings during the course of the investigation. It was important that students could access the software tool across different educational contexts during the investigation and could view other students' work at particular stages of the investigation (e.g. devising group or class hypotheses, sharing the task of collecting data, viewing others collected data to build analyses). The software architecture was therefore based on a central server model, where participants could access and upload to a central database and view other participants' data in real time.

[1] Ofcom 3G coverage maps, published 8 July 2009: http://www.ofcom.org.uk/radiocomms/ifi/licensing/classes/broadband/cellular/3g/maps/3gmaps/coverage_maps.pdf

To enable the students to experience a consistent interface throughout the investigation, the decision was made to build a web based tool, capable of display and operation on any device supporting a web browser. During the trials this meant school PCs in the classroom, Asus netbooks for fieldwork, and a variety of school and home PCs and netbooks for writing up.

3. THE APPROACH

In order to understand the challenge, we applied the following procedures when approaching each investigation:

Identify investigation requirements through discussion with school teachers and students. Research has been carried out throughout the project in collaboration with students and teachers. At the beginning of each investigation we worked with teachers, and as the investigation continued we interviewed students about how and where they were working and if our model of connectivity was adequate.

Site surveys where possible to identify network connectivity. On establishing locations where students would be undertaking their work, we would undertake site surveys where possible, using netbooks and 3G enabled phones to identify existing levels of network connectivity. Network connectivity at students' homes or locations they visited independently could not be feasibly surveyed.

Configuring equipment to utilise existing networks, and improve networks where possible. For locations where we had information about the existing networks (in school through discussion with IT staff and network surveying, and at participants' homes through interviews with students and teachers) we were able to configure equipment to utilise existing networks where possible. Where the network was unknown, the netbooks were set up to run 'locally', accessing a mirror of the remote network services running on the netbook itself. For inquiries on school premises, we were able to work with the school IT staff and extend their existing network to provide network coverage for places we wished to visit. A fallback strategy of working with no connection always has to be assumed and planned for.

Communicate the solutions and possible challenges to the participants and allow them to plan their work accordingly. Ubiquitous computing ideally expects perfect network connectivity; whereas the reality is that coverage is patchy, inconsistent, and of variable quality (Broll and Benford, 2005). Having identified the strategies for network connectivity and possible problems in each environment, the technical research team communicated this information to the participants. As Oulasvirta (2008) has noted, if participants know there is a limitation, they can evolve strategies to adapt to local circumstances and do not problematise it.

4. SOLUTIONS

We used a number of different networking configurations to support students' learning across the investigations and will now discuss examples of each configuration and the associated strategies.

4.1 802.11b/g wireless networking ('Wi-Fi')

802.11b/g standard wireless networking, commonly known as 'Wi-Fi', was considered as the default networking option wherever possible. It is a known and standard protocol, and the central device issued to all participants (the Asus Eee PC netbook) comes with built in Wi-Fi networking. Wi-Fi is familiar to students and teachers, and is already available in schools. Connecting to Wi-Fi on most networks comes at no cost.

This was the chosen option for a Year 8 'Microclimates' investigation, when students aged 12-13 walked around their school grounds visiting a number of locations and entering climatic readings into the software toolkit on the netbooks in groups. Each class went around the school with their teacher and collected data in groups of three or four students. The netbooks were set up so students would use them as thin clients with the web browser directed to the URI of a remote server. Data was directly uploaded in the field and made available immediately to all students and teachers.

The school has a wireless network covering most classrooms, and a site survey showed that a proportion of the grounds were also covered. The IT support staff at the school agreed to set up additional network access points to provide coverage to all the locations the students wished to visit. Technical trials proved critical as these revealed the authentication method the school used required the netbooks to be configured to help them reconnect as they moved between access points. One location, the multi-user games area, needed students to upload their data once they had left, as this had a metal mesh fence which blocked all Wi-Fi radio signals. This approach to connectivity worked well; 150 students in five classes carried out fieldwork and uploaded data successfully.

Two problems were encountered, and resolved. The first was very localised network fluctuations (a few metres across) resulting in poor connectivity in very specific locations. This was resolved by the researchers explaining to the students that we did not have perfect coverage, and they would need to move around to find a better connection. Students, made aware of the 'seams' in the connectivity were able to rationalise the challenge and overcome it, and articulated this to researchers as being similar to the challenge they had with finding a good signal for their own mobile phones. A second unexpected issue was the school encountering power cuts during the week of the trials, meaning that the school's networking equipment could not be powered or connected to the remote server elsewhere on the internet. However, in another project, Enabling Remote Activity, we have devised a portable, battery powered networking configuration which allows us to provide Wi-Fi connectivity between devices in the field (Gaved et al., 2008). With a member or staff carrying this equipment and a mirror of the remote server on a laptop in a backpack alongside the class, students could carry out their data collection by pointing their web browsers to the URI of this laptop. At the end of this session, the researchers synchronised the content from the local laptop database with the main remote server and in the next lesson students were able to continue with their data analysis, returning to the original remote server's URI.

4.2 3G mobile phone networks

3G mobile phone network connectivity is gradually becoming more commonly available across the UK. This offers high speed data connectivity via mobile phone networks, and computers can use this form of network connecting either via: 1) an onboard 3G radio (found in some netbooks, with a slot for a phone SIM card), 2) a USB 3G dongle, containing a phone SIM card attached to a computer, or 3) a 'MiFi' router, offering Wi-Fi connectivity to local devices up to approximately 20 metres and a backhaul connection to and from the internet via 3G.

We tested MiFi routers during an Open Day trial at the University of Nottingham. The investigation was a small version of the Microclimates trial described above, and focused on data collection of climate data around the university campus. Four groups of three students walked around the campus with one netbook per group, each connecting to a MiFi router carried by a member of the research team walking with them. Configuration of the netbooks was similar as to connecting to Wi-Fi, pointing the netbooks connection settings to the name ('SSID') of the local MiFi router. From here the MiFi router handled the connection.

The speed of connection was similar to that of Wi-Fi while downloading web pages and uploading images. Data transfer is charged by the telephone providers, however, so this may not be a suitable mode of connection on investigations where funds for such consumables cannot be released, particularly if there is an expectation of high quantities of data being uploaded and downloaded (e.g. video, audio, high resolution images). Connectivity varied from place to place and even in this urban area there were 'notspots' where no connectivity could be achieved. Furthermore connectivity varied from one service provider to another: we tested three phone providers' networks (Vodafone, 3, Orange) and found quality of service could vary radically between providers, potentially ranging from very good to no signal whatsoever. We also suspect that the the two models of MiFi router we used may have performed differently, though this will require further testing. 3G connectivity was highly variable inside buildings, and for data analysis we switched to the university's Wi-Fi network.

4.3 Services run locally on each machine and synchronised later

In many authentic fieldwork locations, particularly those which the teachers or researchers are unable to visit thoroughly before an investigation, the availability of network connectivity is an unknown. For these environments the safest option is to assume no network and plan for participants to work locally on their own devices and then allow for post-activity synchronisation of data.

This has the advantage of reliability, however it requires that the remote services can be run locally on each device, that no interaction is required between participants during this period, and that data can be synchronised with the remote central server before it is later required (e.g. before the students' next data analysis lesson in the classroom).

This approach was used for an investigation exploring Urban Heat Islands, which required students to walk across two towns, one in the morning, and the second in the afternoon collecting climate data and take supporting photographs. Two groups of students carried out the investigation on two concurrent days, requiring the support team of researchers to install the software on 12 netbooks. At the end of each day researchers had to synchronise data from each netbook and upload associated photographs to the remote central server, ready for the students to access their data either using the school's ICT suite, their own home computers or the netbooks operating as thin clients, and connecting to the now updated remote server.

This approach was reliable, and we have used it several times in situations where we cannot rely on the network connectivity or need a fallback position. However it requires that the mobile devices are capable of running all the services participants require from the remote server, that the support team has time to set up the software locally, and time to synchronise and upload data from the devices to the central remote server before the participants later need access to it. This is a very time consuming process, even if scripts to automate the tasks are available. Furthermore, while participants are operating in this mode, they are unable to share data with any of their colleagues, and the teachers are unable to view their progress.

5. SUMMARY

We have undertaken a range of strategies to ensure network connectivity for participants in the PI project over the last three years; Wi-Fi, 3G, and local services have each been tested and found to have benefits and disadvantages (see Table 1).

To undertake successful fieldwork trials with students and teachers, we have found it is important to recognise that network connectivity cannot be taken for granted and procedures to identify and best utilise existing services must be employed. Where possible we have extended existing network provision, but for locations where this is not possible or the sites are unknown, we have ensured mirrors of the remote services are provided on each student's netbook. This approach requires factoring in significant time for post-activity synchronisation of the data from these netbooks to the central server, which in itself is a risk, as this may not be possible for some investigations. 3G phone networks have proven to be a reasonable substitute for Wi-Fi networks, however their coverage is currently limited and usage incurs ongoing costs.

Table 1. Affordances and limitations of connectivity options

Type	*Affordances*	*Limitations*
Wi-Fi (802.11b/g)	Free to use High bandwidth Commonly deployed in schools	Needs access points set up
3G phone network	Expanding coverage Utilises cellphone networks	Limited coverage Costs for data transfer
Localising services (post-activity synchronisation)	No need for connectivity No bandwidth or data limits	No synchronous communications between participants Requires post-operation sychronisation

We have learnt however that users are able to plan strategies around variable connectivity. Familiar with the inconsistencies of mobile phone connectivity, students and teachers are able to recognize that mobile learning may also suffer the same variability of service. By presenting this issue, and making it plain, participants do not problematise it but rather accept it as a limitation of the system and work around it, often appropriating the system in unforeseen ways in the process.

6. CONCLUSION

Despite the claims of mobile learning optimists, connectivity cannot be assured when undertaking investigations in authentic fieldwork locations. The current real world network infrastructure is "messy", and "regularly mutates" (Girardin et al. 2008). Practitioners and researchers should prepare a number of strategies and be ready to consider different networking solutions for different environments, including always having a fallback to run services on each participant's device where possible. The networking environment is likely to change in the future, and some of the current challenges are likely to be overcome. We can expect better and cheaper 3G phone coverage, leading to possibly a decreasing emphasis on the need to set up Wi-Fi networks. Higher speed wireless networking technologies can also be expected to appear in the near future. However new challenges are likely to arise, such as higher contention ratios (large numbers of people trying to share the same network coverage), and it is likely that areas with poorer network infrastructures will continue to lag behind (e.g. rural areas and those with lower population densities) so the need to adopt multiple strategies to ensure successful networked learning while in authentic fieldwork environments is likely to be of importance for the foreseeable future.

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A Comprehensive Mobile Learning System to Support Training and Professional Improvement of Academicians

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Abstract

In this study, the analysis, design, and the theoritical and technological structure of "Mobile Academic Research Support (MARS) Project",which has been developed to meet academicians' research design and research method oriented needs, has been described. MARS design combines course, online resources, advisor, help, communication and my process tools. MARS holds promise in accomplishing complex tasks for educational and training purposes and provides mobile access to support learning and performance. It provides access to the information on a variety of mobile devices such as i-Phone, Nokia, g-Phone, etc.

Key words

Mobile Learning, Professional Improvement, Performance Support, 3G Technologies

1.INTRODUCTION

Academicians have to adjust changing circumstance in today's world. Otherwise, they may encounter the problem of academic obsoleteness. Mobile technologies can provide a good oppurtunity to support their professional improvement due to mobile devices which are portable, individual, available, persistent, and useful. For instance, they could access any information easily and quickly via mobile devices while they are doing research or giving a lecture. They could utilize their mobile devices whereever and whenever they demand to meet their academic needs. Therefore, "Mobile Academic Research Support (MARS) Project" has been designed to meet their needs related to research methodology. The purpose of MARS is to improve their performance and to support their training on research methodology via 3G mobile phones. In this study, the analysis, design, and the theoritical and technological structure of MARS has been described.

1.1. The Analysis Structure

The Analysis Structure of MARS consists of four steps in this project. These are the review of dissertations, the analysis of research methods needs, the two focus group interviews as well as the survey of the use of mobile learning technologies by academicians:

The Review of Educational Technology PHD and Master Dissertations: 64 Ph.D. and 259 master dissertations were investigated by two different research teams after the related literature about Educational Technology was researched in Turkey (Simsek, et al, 2007, Simsek at al. 2008). Then, the data gathered from these dissertations was analyzed. The results suggested that a great majority of dissertations employed a quantitative paradigm. Most dissertations were based on descriptive models using questionnaires, tests, and scales as data gathering instruments. The samples mostly included the theses of university students. A significant majority of dissertations employed descriptive statistical techniques and only a limited number of experimental theses conducted inferential statistical analyses. Lastly, a considerable number of existing studies have serious problems regarding internal as well as external validity.

The Analysis of Research Methods Needs: The literature reviewed includes research articles, conference papers and research papers relate to the research methodology needs of Turkish academicians. In addition, data was gathered from articles and conference papers and analyzed. The results have suggested that they significantly need support regarding research methods and new research approaches.

Two Focus Group Interviews: The views of researchers on professional improvement needs were taken by conducting interviews with two different focus groups that consisted of six researchers each. The goal of the focus group interviews was to take the responses given to the questions as a result of the interactions between individuals in the group. Since the group dynamics influence the scope and depth of the responses given to the questions, it is possible to obtain a rich set of data at the end of the focus group interviews. The results of the analysis of their views suggested that most of academicians need support regarding research design, research methods, and new research approaches as well as a performance support system to access just in time information, to solve their problems, and to provide interactive coaching and guidance (Özdamar-Keskin & Kuzu, 2010).

***The survey of the use of mobile technologies by Turkish Academicians*:** The purpose of this study is to explore academicians' perceptions of the use of mobile technologies for learning and professional improvement. Besides, this study surveys the attitudes of academicians towards the use of these technologies. The sample of the study consists of academicians (include Research Assistant, Lecturers, Assistant Professors, Associate Professors, Professors) in Anadolu University, Turkey. This study is in the process of data collection.

***Why has MARS System been chosen as a support system for Turkish academicians*?**
Our purpose is to meet their research design and research method oriented needs. Thus, we have designed a comprehensive mobile learning system named Mobile Academic Research Support (MARS). There are some reasons for chosing mobile technologies for training and professional improvement. These reasons are that they

- save time and organizational costs
- prevent serious work losses during the trainings.
- prevent coordination barriers caused by geographical distances.
- decrease academic concentration difficulties based on the cultural and learning styles differences.
- allow to learning right time and right place
- allow to have individual, portable, persistent and useful mobile system.
- support mobile devices diversity
- support multimedia
- have widespread use by academicians.

1.2. The Theoretical Structure

MARS is based on **Performance Support System'** (PSS). PSSs are designed to improve task performance by providing users with just-in-time support and information whenever and wherever they need it. Thus, it provides users with necessary information, guidance and support in certain contexts. By integrating mobile technologies with PSS, PSS has become known as **Mobile Performance Support System (MPSS).** Ahmad (2009) defines MPSS as a technology that concentrates on improving task performance by leveraging mobile technologies at the right time and in the right place to provide information, to support learning experiences, and to guide decision making.

MPSS improves user performance thus it supports mobile learning as well. Mobile learning defined as any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning opportunies offered by mobile technologies (O‟ Malley et al, 2003). It is the center of MARS to provide training and professional improvement in the learning environments. MARS supports Lifelong Learning that describe as learning is a continuous, life long process resulting from acting in situations. Moreover, they can use MPSS in informal learning environments, such as consulting or collaboration with other users or by accessing different information resources in their free time. Additionally, it has used adult learning principles due to the study's target group which is Turkish academicians.

Metcalf (2006) suggests that a comprehensive learning and performance model has a dynamic in relationship to learning, performance support and knowledge base. By learning, people get attitude, concepts, facts, processes and procedures in the educational environments such as live classroom instruction, online e-learning, just-in-time e-learning, self learning experiences using conventional media, on-the-job training or blended web-based and traditional models. Performance support that means accessed on-the job, task specific information, and just in time support without needed to memory resident is provided by coaching and mentoring, paper-based job aids, Electronic Performance Support Systems (EPSS), and embedded performance support. Knowledge base supports the repository of knowledge objects, sharing of best practices, connection to experts and high value information. Metcalf asserted that the mobile technologies could use the best fit for performance support. In the MARS project, it is used this model to enhance learning and knowledge base to get high value information.

1.3. The Design Model of MARS

MARS design combines course, online resources, advisor, help, communication and personel progress tools (Figure 1). MARS holds promise in accomplishing complex tasks for educational and training purposes and provides mobile access to support learning and performance (Özdamar Keskin & Metcalf, 2009).

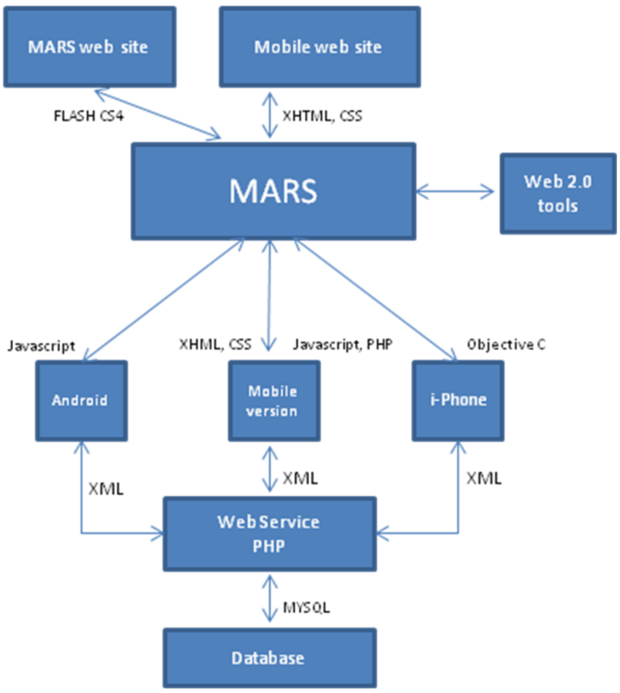
Figure 1- Mobile Academic Research Support System

The course system in MARS has 5 modules named: "What is Research?‟, "Qualitative Research Method‟,"Quantitative Research Method‟, "Blended Research Method‟, and 'Effective Writing Research Papers‟. Each module has sub modules, each containing the full range of checklist, lessons, examples, tests, guidance, references, summaries, and personal progress. The whole content of modules are created and revised by experts who give regular lecture on 'Secientific Research Method and Design' in Masters' and Doctoral

Programs in Anadolu University and the lesson sections are based on the experts' videos on research methodology. The Online Resources tool contains Information Database that integrates with a Wikipedia Web 2.0 tool named as Mobile which contains definition, examples, case studies, and references including text and pictures, E-book, Conference Alert System, and links to the MARS blog and Facebook. The Advisor tool combines Question & Answer, Send e-mail, Send SMS and Chat time. Personal Progress Tool allows users to see their training progress. This system shows whether course modules are started, in progress, or completed. The Help Tool provides guidance about how use the MARS system. The Communication System Tool shows information about the MARS system. It contains phones, numbers, address information, advisors' names and information, and university information.

MARS is integrated with multimedia such as sound, text, images, and video. It is structured to provide individualized information access by i-phone, android application, and electronic environment through other devices. In addition to supporting user collaboration with WEB 2 tools and permitting users to perform tasks about research, users can find information on this topics here easily if they need help. It provides access to the information on a variety of mobile devices such as i-Phone, Nokia, g-Phone, etc.

1.4. The Technological Structure



As shown in the figure above, MARS will be created as, i-phone application, xhtml application and an Android application for 3G mobile phones. In order to develop the i-phone application, the i-phone Software Development Kit (SDK), also based on the Objective C programming language, will be utilized. For its database system, it will use a MySQL Lite database. In order to create an Android application the Android Software Development Kit (SDK), which is based on the Java programming language, will be used. The PHP programming language and Apache servers will be used for 3G technologies such as Nokia, Samsung etc. For its database system, it will use a MySQL database that stores educational content and multimedia files. All information will be stored as tables in the database without information by Web 2 tools such as Mobile Academic Research Support Facebook page, MARS Blog, MARS Twitter and Mobile Wiki. Moreover, MARS web site will be created by using Flash CS4 and the mobile version of MARS web site will be used XHTLM and CSS to desing.

2. CONCLUSION

MARS system aims to meet Turkish academicians' needs on research methodolodgy after analysis process including the Review of Dissertations, the Analysis of Researchers Needs, the Focus Groups Interviews and the Survey of the Use of Mobile technologies. MARS system based on mobile performance support system and mobile learning as well as learning theories in order to provide improvement for Turkish academicians. The Design model of MARS combines course, online resources, advisor, help, communication and personal progress tools. MARS will be created as, i-phone application (i-MARS), html application (m-MARS), and an Android application (g-MARS) for 3G mobile phones. MARS is in development process and it will be aimed to finish on December, 2010

3. ACKNOWLEDGMENTS

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User-Centric Developments

Short Papers

Exploring Theories of Learning and Teaching Using Mobile Technologies: Comparisons of Traditional Learning, eLearning and mLearning

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Abstract
This short paper explores relevant theories for mobile learning and teaching by contrasting it with the learning that occurs in the traditional, didactic lecture and in typical implementations of eLearning. It examines existing mLearning theories and explores these through one example of mLearning, student-generated vodcasts. The application of concepts such as student-centred learning, active learning, learning conversations, existing student practices with mobile devices and the affordances they offer reveal that mLearning, as exemplified by student-generated vodcasts, is fundamentally different from traditional face-to-face lectures and eLearning. However, it is also noted that not all mLearning leads to better educational outcomes and that more emphasis needs to be placed on learner engagement and student-centred learning as fundamental concepts of any mLearning theory.

Keywords
mLearning theory, mobile technology, student-generated vodcasts, higher education

1. INTRODUCTION
Today, using mobile devices, students can be global producers, not just consumers, of text, image, audio, video and multimedia content. The characteristics and affordances of mobile devices for communication, multimedia literacy and "real world" learning are enabling changes in the way we think, create, learn, represent and convey knowledge. Moreover, there has been a realization that mobile learning (mLearning) can work with previously disenfranchised groups in society. This has resulted from the almost ubiquitous adoption of mobile phones across all social strata and across the world, and hence a widespread familiarity with these technologies and the forms of interaction which they promote (Adesope et al., 2007; Ragus et al., 2005; Stead, 2005).

These new multimedia ways of being, knowing, learning and communicating and their implications for formal education need to be better understood. A theory of mLearning is required to inform educational design in order to improve the relevance of education and to better engage the contemporary "digerati", "Generation Y", "YouTube" students.

The aim of this paper is to investigate theories of mLearning by interrogating the alignment between existing theory and practice, and the characteristics and affordances of multimedia mobile devices. The paper contrasts the learning opportunities offered by students generating and producing their own vodcasts (video podcasts) in the university context with the learning taking place in a traditional lecture environment and in eLearning. Our findings show that, while not all mLearning implementations lead to improvements in educational practices, mLearning which places the student at the centre of active learning can lead to high levels of student engagement and excellent learning outcomes.

The paper begins with an examination of some of the existing theoretical approaches to mLearning.

2. THEORIES OF MLEARNING
MLearning researchers and practitioners have begun to formulate theories of mLearning. Some have built on contemporary learning theories, while others have examined the distinctive affordances and uses of mobile devices.

One of the earliest attempts was undertaken by Naismith et al. (2004, p. 10) who classified mLearning according to three theories of learning (behaviourism, constructivism and situated learning) and three "areas of learning" (collaborative learning; informal and lifelong learning; and learning and teaching support). Despite the fact that this classification is one of the most often quoted (for example, Herrington and Herrington, 2007), it does not interrogate many significant learning theories of the twentieth century. Experiential learning, for example, as highlighted by Dyson et al. (2009) and Lai et al. (2007) is useful in understanding mLearning but ignored by these writers.

Another approach is Sharples' (2003) application to mLearning of the idea of "conversations". Originally developed by Pask (1976) and adapted to eLearning by Laurillard (1993), the Conversational Framework focuses on constructing conversations between learners, between teacher and learner, within the heads of learners as they interrogate concepts, and conversations with the world (Sharples, 2003).

Sharples et al. (2007) build on conversational models of teaching and learning by incorporating Activity Theory, and propose a "theory of learning for the mobile age". This approach focuses on the mobility of the learner rather than the technology, and features a dialectical relationship between learning and technology. On one level – the semiotic layer – the learner's movement towards the acquisition of knowledge is mediated by learning resources, social rules, conversation, division of labour, and the context of the learning community. On the other level – the technological layer – learning is seen as an engagement with technology in the form of mobile learning and communication tools which, in the case of new technology, result in the acquisition of new technical skills. A deficiency, highlighted by Sharples et al. (2007, p. 243) themselves, is that this theoretical approach does not give "sufficient importance to what it is that makes a learning activity valuable".

Pachler et al. (2010) argue that approaches based on Activity Theory are too abstract and too complex to be easily implemented. Instead, they propose a "Socio-Cultural Ecology of mLearning" in which three interrelated components come into play: the learner's capacity to learn, or make meaning; existing cultural practices from learners' uses of mobile devices in their everyday lives; and learners' socio-cultural and technological context. This position acknowledges mobile devices as cultural resources and recognizes that learning in informal contexts can be assimilated into formal educational settings. Learning consists of the "transformative engagement with (aspects of) the world" (Pachler et al., 2010, p. 175).

A useful concept for mLearning, noted by Pachler et al. (2010) as well as other authors, is that of affordance. This term refers to the way in which the design of an object naturally invites a user to interact with it in a particular way (Gibson, quoted in Lai et al., 2007). Pachler et al. (2010) draw attention to the affordance of smart phones for a learner to interact with multiple functions due to the convergence of many previously separate devices, e.g., phone, MP3 player, camera, gaming device. Lai et al. (2007) note the affordances of mobile devices to make information available wherever and whenever learners require it, and to provide them with multimedia "note-taking" functionalities, such as image, audio and video recording. Herrington and Herrington (2007, p. 7) note the affordance of mobiles "as tools for complex and sustained tasks and problem solving" rather than for simple transmission. They list a number of possibilities offered by mobile devices to support authentic learning activities, including the use of the multimedia capabilities of mobile devices for developing digital narratives, the gathering and analysis of field data, and student-generated podcasts.

3. THE TRADITIONAL CLASSROOM

MLearning in university education may be contrasted with the traditional top-down lecture, where the teacher teaches and the students listen and take notes (Figure 1). This practice is dominant for reasons of economy of delivery in courses which attract large student numbers (Oliver, 2007). This approach is based on a transmission model of learning informed by behaviourism, in contrast to a more socially constructed and situated view of learning (Goodfellow and Lea, 2007). Academics, who (outside Education Faculties) rarely have formal teacher training, can too easily believe that teaching consists of the transmission of their knowledge to students (Martin and Webb, 2001).

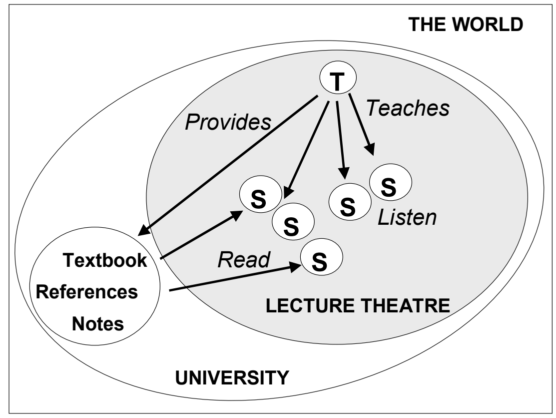

Figure 1: The Traditional Lecture
[T – teacher; S – student]

In large lectures students are generally passive, with the lecturer most active. Learning within the artificial environment of the lecture theatre is decontextualized and not situated, with little engagement with the real world. It represents a very teacher-centred mode of education with few possibilities for student activity. Though lectures provide the opportunity for question and answer sessions, these are often teacher centric: the academics's frame of reference dominates as the "right" answers are given to students (Burns and Myhill, 2004). With so many students present there is inevitably little attention paid to individual learning needs (Oliver, 2007). Laurillard (1993, p. 3) remarks that "It is truly a miracle, and a tribute to human ingenuity, that any student ever learns anything worthwhile in such a system."

4. ELEARNING

From the mid-1990s the convergence of personal computers and the Internet into networked, multimedia information and communication systems supported the growth of online educational practices. These provided the potential for collaboration and learning conversations using communication technologies, such as discussion boards, chat rooms, group spaces, file sharing and email.

However, eLearning has not revolutionized pedagogic practices. For most lecturers, it involves the online provision of learning resources, downloaded by the student, and the answering of students' questions, again a top-down approach to learning (Figure 2). Goodfellow and Lea (2007) observe that, with increasing student enrolments, eLearning focused on mass learning management. Because eLearning tools are good at delivering content more efficiently and to larger numbers of students, the transmission model of education has been perpetuated (Martin and Webb, 2001). Like the lecture theatre, the online classroom is an artificial learning environment, separated from reality, with limited contextualization of knowledge usually offered. Kirkpatrick (2001) points out that the imposition of commercial learning management systems on academics introduced a lack of flexibility in educational approaches, and that conventional, teacher-centred attitudes acted against the exploration of the more interesting potentials of eLearning, with honourable exceptions.

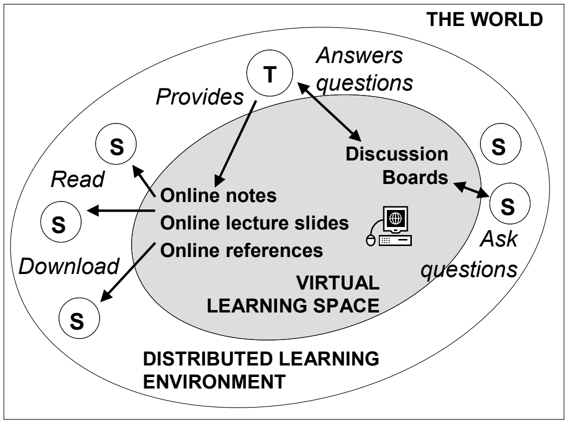

Figure 2: Typical eLearning Implementation

Contributing to the entrenchment of traditional teaching practices was the lack of resources invested in adequate professional development for academics:

> "Educators cannot be expected to complete their conventional full-time load (which is always an overload) and then develop innovative, provocative and appropriate web-based material. To construct evocative websites takes time as well as huge commitments of skill, design, expertise and knowledge." (Brabazon, 2002, p. 68).

5. MLEARNING

Despite the potential of mobile devices to support new learning and teaching practices, mLearning practice is in danger, like eLearning before it, of being dominated by mass content delivery. Already many universities are going down the transmission route through wide-scale provision of lecture podcasts to their students (Nataatmadja and Dyson, 2008). Conceptualizing lecture podcasts in diagrammatic form arrives at a distributed learning model similar to eLearning (Figure 2) but without the facility for students to ask questions. Thus using mobile technology alone is insufficient to create an active learning experience. Nor is learning which takes into account the mobility of the learner from formal classroom to informal contexts sufficient, despite the emphasis on these concepts in the mLearning theories of Sharples et al. (2007) and Pachler et al. (2010).

An alternative to the lecturer producing podcasts is for students to make and share them with each other. To explore the theoretical base of mLearning this paper analyzes a student-generated vodcast assignment which has now been embedded in a large, core communications subject for first-year Information Technology (IT) and Business/IT university students (75-356 students per semester). This case study demonstrates how mLearning can reverse the didactic educational paradigm and create experiences which deeply engage students (Litchfield et al, 2010).

For the assignment, students work in teams of four to research an IT career, plan and video an interview with an IT professional, and edit the video to make a vodcast, which is embedded into a class presentation about the career. The vodcasts are then made available to all students enrolled in the subject in both the current and subsequent semesters via the learning management system.

The different dynamic of the student-generated vodcast, compared to both traditional classroom learning and eLearning, is depicted in Figure 3. Students are active learners, creating new knowledge, which is highly contextualized since the interviews take place in the workplace. The lecturer's role is mainly to support, giving little help since students either know how to use the equipment already or like to work it out for themselves. Video fits within their experience of visual media and aligns with their own practice of recording videos on their mobile devices. The main assistance required is the provision of some video equipment and finding IT professionals to be interviewed. Frequently students use their own cameras and workplace contacts.

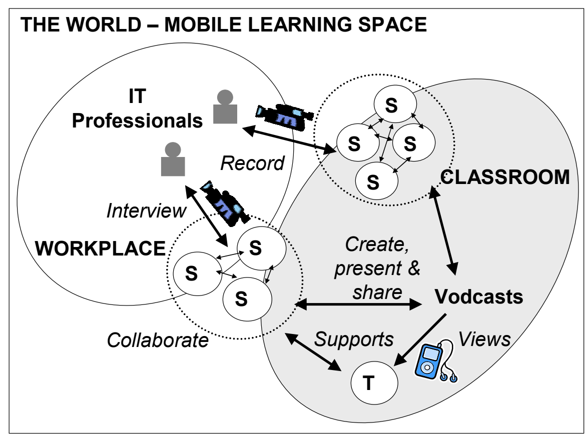

Figure 3: Student-Generated Vodcasts

The student-produced vodcasts combine several learning approaches – including mobile-supported fieldwork, experiential learning and peer learning – which have been identified in the literature as supporting deep learning and higher order thinking (Dyson et al., 2009; Litchfield et al., 2010; McLoughlin et al., 2006). The affordance of mobile devices for multimedia recording creates the basis for learning conversations between students as they view each other's vodcasts. Asking students to produce vodcasts challenges notions of literacy – traditionally conceived in the education system as reading and writing – to include digital, multimedia communication skills and is a transformation long overdue (Davies, 2003).

The vodcast assignment's learning objectives are to enhance students' understandings of the various IT careers open to them and to improve their multimedia communication skills. Students' perceptions of their learning outcomes were evaluated using before and after surveys with Likert scales and these indicated a high level of achievement. While only 29% of students on the beginning-of-semester survey agreed or strongly agreed that they were well-informed about IT career options, this grew to 70% of students with the end-of-semester survey. At the start of semester, 27% of students self-assessed that they had good or very good video recording skills, while at the end this had increased to 49%.

In addition, focus groups were conducted allowing students to express their opinions and then rank these. High motivation levels were demonstrated, with the first-ranked comment being "Unique assessment that was fun". The second-ranked comment was that students appreciated "Developing presentation skills, teamwork and interviews", all desirable professional graduate attributes. Ranked third was the comment "Opportunity to find out about different IT careers … real world perspective", indicating that students appreciated being able to engage with the real world context.

6. CONCLUSION

University learning mediated through and supported by mobile technologies can be very different from both the traditional lecture and eLearning. Mobile devices create the possibility for active, student-centred learning in which students create their own knowledge, collaborate with peers and move into the world outside the university to learn in context. This occurs because of the mobility and affordances for interactivity and multimedia offered by mobile devices, which create the basis for shared learning conversations. In addition, mobile technology is an important aspect of our students' lives and therefore of intrinsic interest to them. In the vodcast assignment, the students did not have to be taught to make or edit their videos, apart from being provided with an introductory workshop.

The continuing use of the transmission model through lecture podcasting indicates that improving learner engagement cannot be taken for granted with mlearning practices. Significantly, student engagement is not sufficiently foregrounded in many of the current theories of mLearning. In fact, improving engagement needs to be at the heart of any useful mLearning theory. It is not sufficient to rely on students' interest in mobile devices, even though this is a good beginning, forming as it does part of the lived reality of our students. MLearning must incorporate sound educational design principles and a theoretical underpinning which reinforces the need for learner engagement through active student-centred experiences.

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Developing a Whole of University Approach to Adopting Hand Held Student Response Tools

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Abstract

Wide scale, scalable and sustainable adoption of technological innovation across whole institutions is acknowledged as a challenge in the higher education sector and failure to achieve this is common. This paper outlines an institution wide approach to integrating hand held student response systems or polling tools into courses and programs at the University of Queensland. The paper discusses factors contributing to the success or failure of wide scale technological innovation, describes the approach taken, some challenges encountered and makes recommendations for supporting institutional wide adoption of mobile learning innovations.

Keywords

student response systems, hand held devices

1. INTRODUCTION

1.1 Student Response Systems

Hand held Student Response Systems (SRS) or polling tools such as Keepads are widely used in universities and other learning environments to encourage greater interaction and engagement between students and lecturers and among students, particularly in very large undergraduate classes. Their use commonly involves the posing of true/false (T/F) or multiple-choice questions (MCQs) to students through their incorporation into Powerpoint slides and other common applications. Students respond to the questions, either individually or in groups, by using a small remote device. An onscreen matrix indicates when all or most students have responded, at which stage the lecturer is able to generate a visual display (e.g. bar or pie graph), which can then be used as a basis for further teacher or student activity. Diverse types of questions can engage students in collaborative problem-solving, require them to demonstrate recall or understanding of information (e.g. from lectures or readings), garner their opinions on sensitive issues relating to course content or enable the collection of feedback on aspects of the course or teaching. There is evidence emerging that the use of such tools can have a positive impact on learning (Brush, 2010; Kay & LeSage, 2009a; 2009b).

1.2 The University of Queensland Situation

There is already considerable use of SRS at the University of Queensland, much of it innovative and beneficial to the learning outcomes of the students who had opportunities to use it. However, practice is fragmented, there is no institutional approach to guide best practice in essential matters such as the purchase and maintenance of hand held devices and software, the provision of handsets to students, the professional development of staff including the development of questions or the evaluation of the effectiveness of using these devices. Some staff who had expressed an interest in using such technology were either unable to access it from existing users or their organizational unit was unable to afford such tools. Consequently, given the level of expressed interest in using hand held SRS tools, staff working with academics either using or interested in adopting SRS felt that, in order to effectively address the issues outlined above, it was in the University's best interest to consider the implementation of a 'whole of institution approach' to using SRS. While other polling tools are available such as those within classroom management tools such as Smart Sync (http://smarttech.com/us/Solutions/All+Products) and DyKnow (http://www.dyknow.com/) and web conferencing tools such as Wimba (http://www.wimba.com/) and Elluminate Live (http://www.elluminate.com/), these tools are currently not viable for use within large lecture theatres, where most use of SRS tools at the University of Queensland is intended. Mobile polling tools such as votapedia (http://www.urvoting.com/) are dependent on large amounts of wireless bandwidth which is not always available and it can be inefficient or ineffective with large numbers of students. Additionally, using student response tools that require a mobile phone means that all students will need to have a mobile phone that they can use to participate in such activities, which is not always the case. Consequently, a request was made to the senior manager with responsibility for teaching and learning that a working party be established to provide advice on how to do this in the most appropriate, effective and efficient way. As an outcome of this approach to senior management, a small group of staff was assigned to a working party with the brief of identifying the need for such an approach and developing recommendations to submit to the central committee responsible for decisions relating to elearning. This working party consisted of staff with responsibility for supporting the implementation of innovations and key users of SRS tools in the institution. The working party had a strong focus on identifying an approach that would enable successful and sustainable widespread adoption of the technology across the institution and that would support the development of appropriate teaching and learning practice with a focus on encouraging and supporting student engagement in learning activities.

2. BARRIERS AND SUCCESS FACTORS FOR SUCCESSFUL WIDE SCALE ADOPTION OF TECHNOLOGY

2.1Barriers

With the marked exception of Learning Management Systems (LMS) such as Blackboard and Moodle and lecture recording or lecture capture tools such as Lectopia, large scale implementation of technological innovation in higher education is generally lacking strategic policy planning and frequently results in failure (Smyth et al, 2010; Keegan et al, 2007). Successful wide scale technological innovation is a frequently complex and fraught activity for institutions. Romiszowski (2004) suggests that, when it comes to technological innovation, too often the focus is on the technology rather than the pedagogy and little thought is initially given to proper implementation and making it work. Romiszowski also makes the point that when things go wrong:

> …in education, there is a strong tendency to do as John Dewey pointed out way back early in the last century: throw the baby out with the bath-water (p.17).

Consequently, many projects that encounter problems are abandoned in favour of other tools that may suffer similar or worse problems, rather than consider how the original innovation might be amended or adapted to resolve issues. Erhmann, (2000) also identified that there is a tendency to allocate all successes to a newly chosen technology and equally to blame it for all failures, and then look to the next technology to address the problems.

Further to this issue Romiszowski, highlights the role of project management factors in contributing to failure in successful and sustainable technological innovation including:

- Lack of ongoing support from management
- Failure to create an organisational culture for producing elearning,
- Failure to adequately manage project scopes, risks and evolving requirements throughout the e-learning project
- Failure to perform meaningful reviews to ensure an environment of continuous process improvement (p.23).

Amongst several other factors similar to those discussed by Romiszowski, Ehrmann (2000) highlights 'rapture' with technology as a significant factor in the failure of technological innovation. He describes 'technological rapture' as being:

> … so mesmerized by the newness of the hardware or software that we are blinded to factors important to the successful use of that technology.

This is in keeping with Romisowski's (2004) view that too much focus goes on the technology itself and insufficient thought is given to what is necessary to make it work.

Where technological adoption is successful, such as in the wide scale adoption of LMS and lecture recording systems across the sector, change practice can be less successful. In the majority of cases, regardless of the type of innovation, lecturers make no change to their teaching and learning style or curriculum design to incorporate the new technologies in ways that best exploit their potential (MeKeogh & Fox, 2009; Gosper et al, 2008, Kirkup & Kirkwood, 2005).

2.2 Factors that Influence Successful Technological adoption

Smyth et al, (in press) in researching the uptake of rich media technologies found that a number of factors were essential to successful adoption of this technology.

- Coherent institutional policies
- Network infrastructure
- Staff awareness and preparedness
- Provision of technical support
- Ongoing financial support
- Innovation in pedagogy. (Smyth et al, in press,)

These factors can also be considered of critical importance in considering the adoption of other technologies.

Further to this, Smyth et al, (in press) found that where there was a strong correlation between business planning and the institutions strategic teaching and learning goals, implementation was likely to be more successful. Consolidating this view, Rossiter (2007) indicates that in order for technological innovation to be successfully integrated it needs to be part of the organisation's central business activities and needs to be considered by the main decision making processes within the organization.

However, as Romisaowski, (2004) points out, organisations also need to know why they are investing time, effort and funds into particular activities. Therefore a thorough approach to:

- Identification of the problem/need
- Analysis of the problem/need, and
- Overall strategic planning decisions including a well conceptualised implementation approach to address the problem/need

are necessary processes in achieving successful outcomes in wider scale adoption of technology. Further, Romisowski (2004) proposes that a systems approach that considers all aspects required to implement and support technological innovation should be considered if successful adoption of technological innovation is to occur.

In keeping with other researchers in this area Ehrmann (2000), also advises that strategies for successful technological innovation need to ensure support from key areas and staff. Without the support of key management to ensure sufficient funds and appropriate approaches for implementation of all the changes required to embed new technology into institutional activities, success is unlikely. Ehrmann (2000) also counsels that it is critical to continually assess progress, as part of the implementation plan therefore including an evaluation strategy is an essential part of the adoption process. Significantly, Ehrmann (2000) recommends that using 'yesterdays' new technology is more likely to result in success than waiting for the 'next best thing'!

3. DEVELOPING AN APPROACH FOR THE SUSTAINABLE ADOPTION OF INNOVATION.

In collecting information to develop the 'whole of university approach' the working party used a set of ten questions to seek opinions from stakeholders (staff and students) on the use of student response systems and how a whole of university approach might look, including funding models. A systems approach similar to that advocated by Romisowski (2004) was adopted. In developing the guiding questions consideration was given to the following:

- the kind of SRS system that would best meet the university's needs
- leasing versus purchase of devices
- management and distribution of hand held devices and other required equipment
- maintenance requirements
- budget requirements and budget management
- support requirements for staff and students
- an appropriate academic development program
- a communications strategy
- an evaluation plan

Barnett (2006) suggests that it is important to consider both positive and negative views in relationship to the use of SRS technology and to take this into consideration when preparing to adopt the technology. The consideration of both positive and negative views was also seen as of key importance to university management. To add to the information collected, desktop research identified a number of other institutions including the University of Wisconsin and Purdue University that have taken a whole of University approach to adopting student response systems. Theses institutions had well-developed implementation plans and included strong academic development and evaluation components. This information, along with guidelines drawn from the literature for successful adoption of technology, guided the development of five broad recommendations.

In developing the recommendations the working party sought to ensure the adoption of a system that was cost effective and would be supported by central budgetary processes to ensure sustainability. The need for an implementation plan that included a comprehensive staff development strategy was viewed as key component of developing the 'whole of university' approach to adopting an SRS system.

While the recommendations were broad the working party included specific detail and a range of options to support the decision-making processes. For example, a cost benefit analysis for both leasing and purchase of the equipment was provided to the committee. A plan for ensuring ongoing maintenance and replacement of devices was also recommended. Additionally, based on the consultation with stakeholders and an analysis of processes at other institutions, options were provided for managing the distribution of the hand held devices and receivers. It was strongly suggested that loaning the handheld devices through the library was a viable approach and one viewed favorably by students.

Additionally, linking the proposal to the university's teaching and learning profile and teaching and learning enhancement plan was an important part of gaining support from key decision makers. As increasing student engagement in teaching and learning activities is an identified priority, this associated the proposal directly with the university's strategic direction (Smyth el al, in press).

The working party developed five recommendations as a framework for adopting the technology.

3.1 Recommendation 1: An Exploratory and Proactive Approach

That the University of Queensland continues to use and explore applications of existing and emerging student response tools including hand-held devices, software polling tools and mobile phone options such as votapedia, and emerging commercial mobile phone applications such as the internet enabled version of keypad and support innovative projects in relation to these tools.

3.2 Recommendation 2: An Institutional Approach to Provision

That the elearning committee oversees the implementation of a single institution-wide leasing arrangement building on current arrangements to support the identified and potential need for a student response system at the university. A university wide process for:

- Funding the system,
- Distributing the hand-held devices and the associated receivers,
- encouraging 100% take-up by students in classes where the systems are being used
- developing participant lists

needs to be developed as part of this implementation process.

3.3 Recommendation 3: Staff Development and Support

A comprehensive staff development and support program addressing all aspect of using SRS systems needs to be implemented. This should include the development and implementation of clear guidelines to support uptake and application and ongoing use of student response systems applications at the university and the provision of appropriate help-desk support. Seed funding for projects where appropriate should also be considered.

3.4 Recommendation 4: Communication

That a comprehensive communication and recruitment strategy including canvassing of interest in the use of clickers, and information about all aspects of the proposed system be made available on the appropriate websites. Information sessions should be conducted on all university campus prior to support adoption of the system.

3.5 Recommendation 5: Evaluation

The evaluations section of the university should be approached to assist with the development of an evaluation strategy to determine the effectiveness of the adoption of an institutional–wide approach to using Student Response Systems.

3.6 Challenges

The proposal faced several challenges at the committee level. These included a focus on exploring emerging mobile phone technologies such as votapedia, concerns about budget allocation and competing priorities for elearning funds. Ongoing Communication and discussion with all stakeholders was critical in getting the proposal adopted.

4. CONCLUSIONS

Adoption of a whole of University approach to using hand held student response systems has proved challenging. The recommendations were submitted to the committee for consideration in mid 2009 and after considerable debate and discussion with the working group were adopted by the committee in early 2010. An implementation plan is currently being developed.

The approach outlined here highlights the importance of the involvement of key decision makers and processes (Smyth et al, in press; Romisowski, 2004; Ehrmann, 2000) for successful wide scale adoption of technological innovation. The issue of competing priorities for scarce funds means that establishing a well founded need for technological innovation (Romisowski, 2004) can be of critical importance. Equally, plans and approaches need to be well developed and conceptualized. Ongoing communication to allay concerns of members of central decision making bodies and keep stakeholders up to date on developments is an important part of the process.

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Learning Design for mobile and contextual learning

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Abstract

The aim of this paper is to apply the pedagogically neutral language of Learning Design – LD (a defacto standard specification for online learning) in the process of modeling contextual information into mobile learning. This will allow mobile and contextual learning to benefit from the numerous available LD-compliant runtime environments and editors. Specifically, this paper proposes: (1) a conceptual extension of the IMS LD Information Model suitable for mobile and contextual learning, (2) the extended Information Model, (3) the resulting context aware model and (4) the ontology derived from this model.

Keywords

Learning design, mobile learning, context-awareness

1. INTRODUCTION & BACKGROUND

According to (Berri et al, 2006), one of the major research challenges in the mobile learning field is "the development of methodologies that make use of the learning expertise already adopted in desktop-based learning and adapt it to suit mobile environments". Moreover, Dey (2000) indentified the need for suitable context model, which describes the relationships among context types (such as location, device, and activity) and facilitates inference and context abstraction when building context-aware applications. Additionally, the idea of a Context-aware mobile Service Oriented Architecture (SOA) is adopted in several research efforts related with mobile learning, like (Chang et al, 2008). As written in (Wilson, 2005) "a service oriented approach does not preclude also using portals or any data warehouses and is in fact agnostic about how the rest of the enterprise is configured, which is why it makes it a good approach for integration in heterogeneous environments". On the other hand, the use of the Learning Design approach along with SOA has already been used in e-learning (Mc Andrew, 2006), where: "a service-oriented approach to services and tools is especially relevant to a Learning Design perspective and the two can be seen as interlinked. Environments configured as services have the potential to accommodate calls on specific instances of services". Finally, the idea of using Learning Design for mobile and personalized learning is not new, since it has been used in (Siadaty el al, 2008).

The Learning Design approach serves here as the basis of the design of the context-aware model, because (IMS GLC 2003): (1) it allows various kinds of learning strategies to be expressed and (2) its language itself remains pedagogically neutral. The remainder of this paper is about the application of IMS LD for learner mobility and context awareness and the integration of this specific Learning Design-based context-aware model in a Service Oriented Architecture.

2. RATIONALE & MOTIVATION

In our approach, the key points befit with the following research goals:

- to facilitate the numerous already existing LD-compliant editors and players in the field of mobile and contextual learning (RELOAD editor, CopperCore editor, CompediumLD, etc). This introduction of LD in mobile and contextual learning could be of interest to the research field (e-learning and m-learning), the instructional designers, the standardization bodies (IMS, CETIS, JISC,..) and the industry. It could be seen as a focal point in order to avoid the spread of technical standards for m-learning and promote interoperability.

- to sustain re-usability, avoiding the need to redesign from scratch when moving from e-learning to m-learning; this implies that m-learning in this approach is being considered as a wider concept of e-learning. This also implies our view towards the relationship between context and generalization. Here, m-learning is viewed as the generalization of the educational situation (and e-learning, in particular), namely that we cannot assume anything about the position and movement of the learners (or the tutor) and their equipment. This (lack of) assumption forms the basis of our architecture. This rationale also implies that the authors are aligned with the interesting definition of m-learning as "learning across contexts" (Walker, 2006). Technically speaking, since there is a plethora of LD-compliant runtime environments, editors and players already available in the market (most of them open source software) designed for desktop e-learning, this paper examines how to extend/augment these tools in order to include the case of mobile and contextual learning, as well.

- to sustain interoperability in the m-learning field by promoting the use of an open technical specification. While m-learning is still in its infancy, avoiding the spread of technical standards for it is vital.

- to design a suitable context- aware Service Oriented Architecture that will focus on the pedagogic necessity (a term defined here by: the learner's characteristics, the learning objectives and the prerequisite knowledge) and will also include a layer of 'educational Quality of Service' (its functionality is being described in more detail in the remainder of the paper) .

3. THE EXTENSION OF THE LD INFORMATION MODEL & THE RESULTING CONTEXT AWARE MODEL

The proposed extension of the Learning Design information model is shown in the UML diagram in figure 1 below. The non-colored part of the UML diagram comprises the IMS LD information model which specifies learning activities performed within an environment that contains learning objects and services. The colored parts of the diagram constitute our contribution: the generalization of the conceptual design of this model, in order to include mobile, personalized and contextual learning. Learning Design is represented in a well-defined XML binding format and has three levels (Koper, 2005;IMS GLC, 2003):

- Level A contains the core language of LD (components, roles, activities, environments)

- Level B provides the inclusion of properties and conditions to Level A, allowing more sophisticated control and types of learning. These conditions provide the necessary capability for instructional designers to define rules as to what actually happens when certain events take place.

- Level C adds notifications, both between system components and the participating roles of the learning process. “Activities can be set as a consequence of dynamic changes to the learner's profiles and/or of events generated in the course of the learning activities. It can also be used to trigger messages being dynamically sent to participants. This enables the automation of learning flow activities, that may be triggered by the completion of tasks, rather than the learning flows being pre-determined” (IMS GLC, 2003).

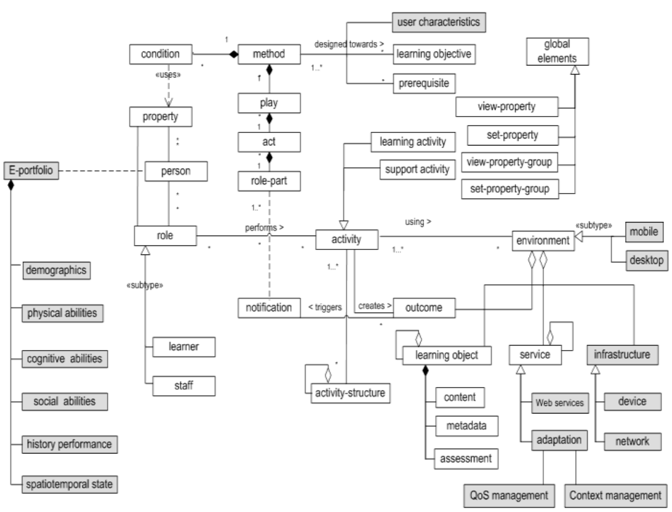

Figure 1: The context-aware m-Learning Design (cam-LD) Information Model (Level C)

In our approach, the changes in properties will also depend on context-triggered actions (e.g. actions triggered by the satisfaction of property values derived from contextual data, like spatiotemporal information) and implicit notifications (i.e. messages exchanged between the system components) will also depend on context changes. For example, the setting (the completion of an assessment) of the properties defined to store the performance of the learner (i.e. the results of the assessment) triggers condition ‘evaluation’. This condition may be defined on the value of certain parameters (prerequisite knowledge, the value of the counter that counts the number of attempts and the learner’s time availability). These parameters do not have static weights in every use case, but their importance changes dynamically.

This information model in our research work is part of a wider conceptual design of an m-learning environment, that is shown in the UML diagram below. The context-aware model involves (see figure 2):

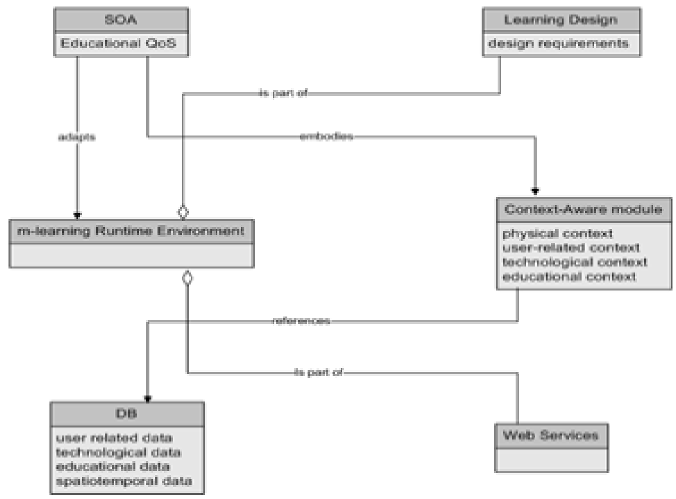

Figure 2: UML block diagram

- Physical context (spatiotemporal characteristics, including motion)
- Technological context (characteristics of the ICT infrastructure such as bandwidth) and the device (screen size, battery, storage, connectivity etc)
- User-related context with traditional user profile characteristics (like age, sex, existing knowledge etc) combined with more sophisticated characteristics (learning style, using the Felder-Silverman Learning Style Model).
- Educational context (characteristics of the ‘subject’ being learned)

4. EXAMPLES & USE CASES

4.1 Examples

The context management module stores the contextual information that will be referenced by the adaptation service (see figure 1). For example, adaptation to the user characteristics involves him/her prior performance and knowledge level and consequently, performance history (as user-related context) should be gained by storing e-portfolios in a relational database (see figure 2) or storing them as XML documents in a repository.

Other examples of context awareness and personalization in learning situations are mentioned below (Mavroudi & Hadzilacos, 2010):

- an image is transmitted from a learner (found in an art exhibition) to a classmate. Depending on whether it is being transmitted during a history of art course, a painting course or a museum curator training session, the image quality will be different. Educational context (i.e. characteristics of the ‘subject’ being learned) has a central role in this approach and implies a number of design requirements.
- a video containing a choreography of a traditional dance is being delivered to a learner. Depending on whether it is being transmitted in the context of a dance lesson for professionals or in an ethnography lesson, then the video is being transmitted in a high quality or not. In the first case, if the available bandwidth is inadequate to transmit the video in a high quality, then the video won’t be transmitted until the bandwidth reaches the desired level and a message is displayed to the learner in order to inform him/her about that. In the latter case, the video is being transmitted in a low quality, since the details of it are not considered important.

The examples above also introduce the new notion of ‘educational Quality of Service’ (Mavroudi & Hadzilacos, 2010). Another example of the use of the educational Quality of Service would be the relationship between the format type and the granularities of the Learning Objects and the mobile-LOs: rich media objects required more computational resources that plain text. Dalziel (2005) contends that for the necessary control and flow between the various components through a Learning Design driven environment, rich integration is the better option, since “richly integrated components…provide a seamless, integrated (e-learning) environment for both learners and teachers, with better potential for reliable Quality of Service.” He continues on arguing that “what is required is both a means of testing some of the assumptions in the service oriented approach and a tool that can interpret the kind of generic service descriptions set in such an approach so that they can be used with Learning Design”. In addition to that, when applying this argument in mobile learning, the challenge is how to configure dynamically the requirements of the Learning Objects and mobile-LearningObjects by balancing what we could afford (due to the lack of computational resources) with want we need (stemming from the educational necessity). Undoubtedly, both LOs and m-LOs should be accompanied with educational metadata suitable for desktop-based or mobile learning (Chan et al 2004), respectively. Tagging with suitable metadata elements could help indexing and archiving the most relevant LOs and increases their reusability.

4.2 Use Case: Using Virtual Labs

The use case “Using Virtual Labs” is inspired from the IMS Learning Design Best practice and Implementation Guide (IMS GLC, 2003). This document contains a collection of use cases, like those mentioned below:
- adapting units of learning to learner profile
- obtaining culturally relevant content for problem-solving
- designing content for re-use between groups
- using virtual labs
- adaptive learning delivery
- blended learning delivery.

In the rest of this paragraph, the “Using Virtual Labs” use case is transformed and enriched with the possibility of mobile and contextual learning.

The aim of this use case is to take advantage of real-time events in labs along with simulations in virtual labs combined with chat, mentoring and other functionality. The adaptation mechanism, among others will ensure that “the call to a service will not result in a broken link and that some alternate experience can be created” (IMS GLC, 2003). In this scenario, some of the learners are inside the classroom in front of their desktop PCs and some of them in the real lab. The learning activity involves the implementation of an experiment. The learners found in the lab interact with the ones in the classroom by transmitting to their classmates the experiment taking place in the real lab and then they simulate it in the virtual lab (through the use of an online virtual world). Should the learner require assistance or mentoring during the activity, then the email service or the forum service (asynch) or the chat service (synch) is used among learners or between learners and their tutor, respectively. The UML activity diagram for this example is shown below:

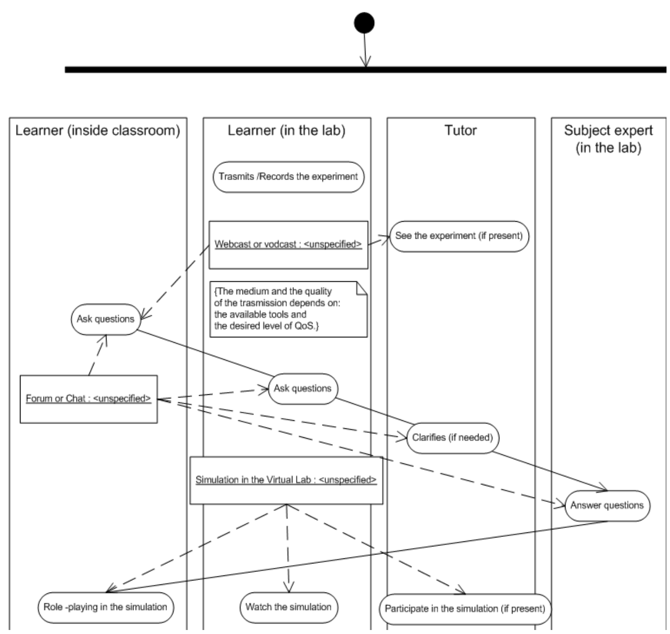

Figure 3: UML Activity Diagram

5. AN ONTOLOGY-BASED FRAMEWORK FOR C-A MOBILE LEARNING

The review of the recent bibliography shows that the ontology-based approach is the most efficient for the purpose of context modeling (Strang & Linnhof, 2004) in conjunction with the following parameters:

- distributed composition and administration of a context model and its data
- partial validation of contextual knowledge
- richness and quality of information,
- incompleteness and ambiguity of the set of the available contextual information
- level of formality; for example, to perform the task "connect with the learners near to me", it is required to have a clear definition of what "near" means to "me".
- applicability to existing environments.

Part of the classes and the properties of the resulting ontology (in Web Ontology Language - OWL and using the Protégé UML editor) is shown in the figures 3 and 4 below. This ontology it is aligned with the Information Model of paragraph 3 and will be part of the context-management engine of the m-learning environment.

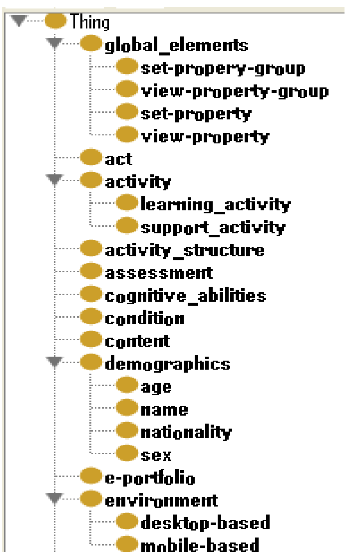

Figure 4 Part of the cam - LD ontology and its classes

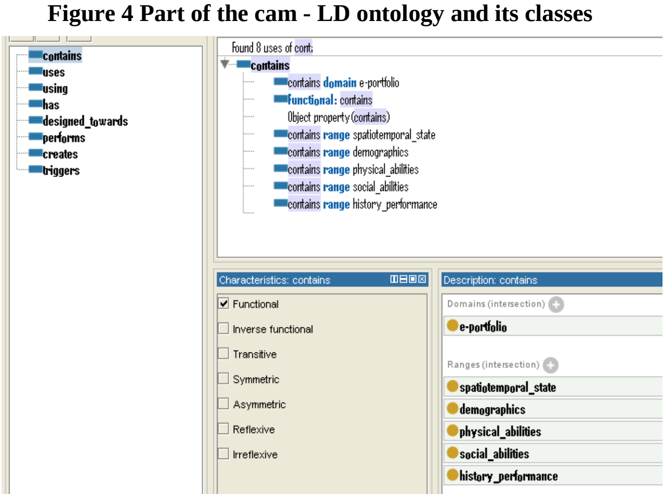

Figure 5 The cam - LD ontology and its properties

6. CONCLUSION

As found in the recent bibliography, the ontology-based method for modeling contextual information has clearly more advantages than other methods (namely: key-value models, markup scheme, models, logic based models and object oriented models).

Possible applications and future projections involve the added functionality to the LD-compliant environments so as to include mobile and contextual learning use cases. The challenge is to apply suitable pedagogies in these use cases, because the 'right pedagogy' still remains an open debate among the various stakeholders, since it entails the right personalization and user modeling techniques. In terms of learning theories, in the recent bibliography frequently found and successfully used in various experiments in the field, are: experiential learning, constructivism, case-based learning, problem-based learning and situated learning. Consequently, the use cases that will be applied in our framework will be primarily based in these pedagogical approaches.

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Studying Collaboration during a Scientific Inquiry Fieldtrip: an in situ study with mobile technologies

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Abstract

This paper studies the collaboration of group members collecting data during a school field trip augmented with mobile technology and propose guidelines for re-designing their activities. Focusing on how students engage with the task at hand, we examine how their collaboration changes over time and what each group member does to support or hinder the collaborative task. Based on the findings, we identify the need to address reflection in the field and suggest ways to support it by providing real-time visualization while in the field, or by changing the role of the researcher or one of the group members.

Keywords

Inquiry learning, field trip, collaboration in situ.

1. INTRODUCTION

Digitally augmented field trips have been increasingly experienced by teachers and researchers in science education. Digital augmentation supports a pervasive environment that will enable students to more extensively connect, reflect on, explain and hypothesize about the physical world around them in relation to their formal learning experiences from the classroom (Rogers et al., 2005) Using handhelds with data logging probes attached, students can collect real-time data out in the field, and either analyze them on site or download them back in the classroom for further analysis and comparison. Through the use of real data, tools, and locations, students have access to authentic inquiry that matter to them (Squire & Klopfer, 2007). However, previous research has also identified difficulties of students to deal with the complexity of experience when out in the field. Eshach (2006) suggests that this is due to the novelty effect. "Students, when entering an unfamiliar location, might develop anxiety, and as a result be involved in off-task activities which may distance them from executing the learning tasks at hand."

In an attempt to study students' challenges during a fieldtrip with handheld devices, this paper will examine the collaboration of group members collecting data during a school field trip augmented with mobile technology and propose guidelines for re-designing their activities. The aim of this work is to analyse how the group collaborated in the fieldtrip and how students engage with the task at hand while they were out of their usual school practices. In particular, two questions are addressed. First, how does their collaboration change over time? Second, what does each group member do to support or hinder the collaborative task?

2. THE CONTEXT

This fieldtrip was carried out part of a larger inquiry-based intervention that took place over a period of 4 weeks in a class of 13 year old students (UK Year 8) in an inner city secondary school. The intervention included 10 science lessons and the overall learning objective across the lessons was for the students to understand the process of a scientific inquiry (Anastopoulou et al., 2010). Prior to the field trip, the students had specified predictions around the man-made environments, pollution and wildlife and framed an inquiry question ('what is the effect of pollution on wildlife'). Following Orion (1993) advice, they were also prepared for the fieldtrip by showing them the geographical grounds of the nature reserve, their task in the fieldtrip and how technology could support them in this process.

During the fieldtrip, the students observed wildlife in the nature reserve and collected environmental data to understand the local habitat. They recorded their observation on the Personal Inquiry toolkit. Students also recorded the sound levels of three different routes in the nature reserve which they aligned to GPS coordinates and photo data. Based on data of three different paths, they identified which path was the noisiest. Finally, students visualized their sound data on Google Earth and they also reflected on all of the collected data during the day.

2.1 The technology

The Personal Inquiry toolkit comprises of a software application, called nQuire, and associated hardware support for conducting the inquiry (including cameras, GPS trackers and sound sensors). The nQuire software, running on both mobile PCs and regular desktop machines, provides 'scripts' that guide the learners through the process of defining, organizing and carrying out their inquiry, and resources their decision making and progression through the inquiry (Anastopoulou et al, 2009).

3. METHODS

To address the research questions mentioned above we chose an *in situ* approach. *In situ* studies provide rich and useful data that can be used to evaluate the situated design experience of the mobile experience. To capture the group interactions during their task, one member of the research team accompanied the group and videoed the whole data collection procedure. If necessary, the attending researcher offered assistance but otherwise it has been avoided to interfere with group interactions.

3.1 Procedure

The implementation of the bird observation study took place during a one-day field trip to a nearby nature reserve and it was organized in collaboration with staff of the nature reserve station. Prior to their data collection, the students of the whole class were asked to form groups of four and to agree on the distribution of the different mobile devices (mobile PC, digital camera, GPS tracker and sound sensor) within the group. To analyse the task, each device refers to a role assigned to the group members: e.g. the sound (recorder) student, the camera student, the GPS student and the netbook student. Their sound data as well as their photos subsequently were seen on Google Earth. Sound readings were recorded continuously along the route they were walking. The link of sound and GPS reading was ensured by simultaneous activation of the devices at the beginning of the whole activity. To connect the photos to the sound data, the students had to stop and collocate at several points along the path, determine the position by GPS, and take a picture at each point of data collection (PDC). For the connection of photograph and GPS reading it was necessary to synchronize the operation between the two students equipped with GPS tracker and camera, and to minute time and coordinates. The latter was realized through the netbook student by entering the data reported by the GPS student. Figure 1 provides an overview of the sequence and the different individual roles within the group task.

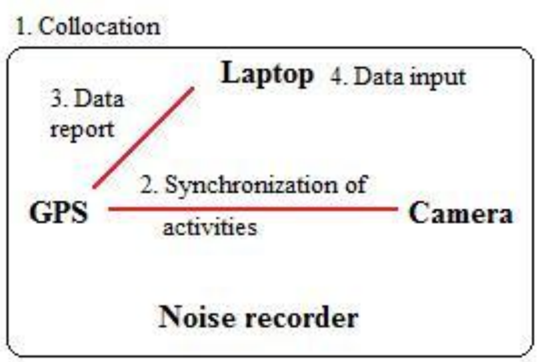

Figure 1. Overview of the sequence and the different individual roles within the group task.

3.2 Data Analysis

According to Jordan and Henderson's interaction analysis (1995) we performed a 'content listing' as a first step towards analysis. The content listing included annotations, explications of events and time durations of the identified events. During content listing, it became apparent that the focus of analysis was the Period of Data Collection (PDC). To get a first impression on how the group's performance on the data collection task developed over time (first research question), we identified that the duration of PDCs is central to understand the group's development in terms of task completion. A PDC started when the first student reached the place where the subsequent data collection took place and it ended when the netbook student finished entering time and coordinates (which was mostly coincident with the whole group leaving the place). In a second step, video material was reviewed by the first author and significant segments were identified and transcribed later on. At this step, PDCs, as they are displayed in figure 2, were also sub-divided into three tasks: 1) collocation of all group members, 2) the actual collection of data and 3) the report and input of the data.

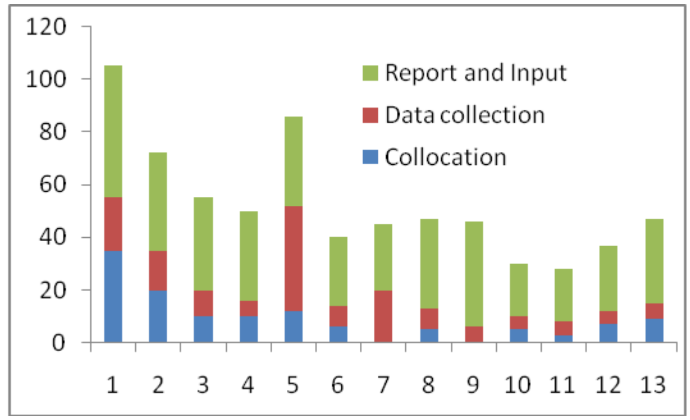

Figure 2. Duration of PDCs across time

To answer our second research question ('what does each student do to fulfill or hinder the collaborative task'), we developed a coding scheme to categorize each student's contribution within one of three levels (Table 1).

Table 1. Individual engagement of students

Engagement	Description
Over Average (+)	Individual engagement ensures the fulfillment of the whole group's task
Average (0)	Fulfillment of individual requirements: Netbook: Collocation, entering data GPS: synchronized activity together with camera, data transfer (reporting to Netbook student) Camera: Collocation, synchronized activity with GPS Sound tool: Collocation, ensure no disturbance of sound recording
Under Average (-)	Endangerment of the whole group's task completion, no fulfillment of individual task's requirements

4. FINDINGS

As shown on Figure 2, in the course of the activity, students completed their task faster (with an exception during PDC 5) so they seem to be familiar with the task. In particular, the sub-processes of collocation and data collection were quicker whereas the required time for report and input of data remains nearly the same over all PDCs. These findings suggest that collocation and data collection require agreement and coordination of activities among the group members which gets increasingly automated over time. The duration of report and data input remains approximately the same, as this is mainly determined by the typing speed of the netbook student.

An exception of the above is PDC 5 when a shift on the decision making process takes place. By reviewing the video for a second time, it became apparent that during the previous PDCs (1 to 4), the activity of the group and especially the synchronization of GPS recording and photo taking was coordinated by the netbook student. In PDC 5, however, the camera student and the GPS student realize that they don't necessarily need the netbook student for their task so they decide to synchronize their activities on their own, without waiting for the agreement of the netbook student. The synchronization of GPS recording and photographing is initiated by a countdown (Extract 1).

Extract 1. Shift of the coordinative role at PDC 5.
Netbook: Right, three, two …
Camera: Wait, I'm not even ready.
Netbook: Right, right.
[GPS and Camera student are talking to each other (not understandable).]
Netbook: You got five seconds.
[GPS and Camera student grumble.]
Netbook: Right. Five, four…
GPS and Camera student complain: What are you doing?
Netbook grumbles: Oh … then.
GPS and Camera: Three, two, one.
Netbook: Right. Three, two, one. [Very slowly]
Sound recorder: No. They took it yet as you …

3.2 Degrees of engagement

The video analysis also revealed that at some points, individual students ensured the whole group's task fulfillment by either coordinating the group's activities or mediating among different group member's opinions. For a more detailed insight into the individual student's contribution to support or hinder the whole group's performance, we analyzed each PDC according to the coding scheme described in Table 1. Figure 3 provides an overview of each individual student's engagement over the whole data collection procedure. A positive spike indicates an activity that exceeds the average individual contribution. Negative spikes represent situations where students didn't fulfill their individual task and thereby risked the whole group's performance.

During the first two PDCs the group's activity was mainly coordinated by the netbook student. He made central decisions regarding the choice of a suitable place for collecting data and he ensured the collocation of all group members as documented in extract 2.

Extract 2. Collocation and data collection at PDC 2.
Netbook: I want Brad to take a picture of the view or something. Where are we going?
Researcher: We are going ahead. It's up to you where you want to stop to take photos.
Netbook: Oh, we'll take a photo of the building.
Researcher: Well you need to take nice interesting photos.
Netbook: Right. Pete, go on then. Right. I'll say three, two, one. Right. Pete get ready.

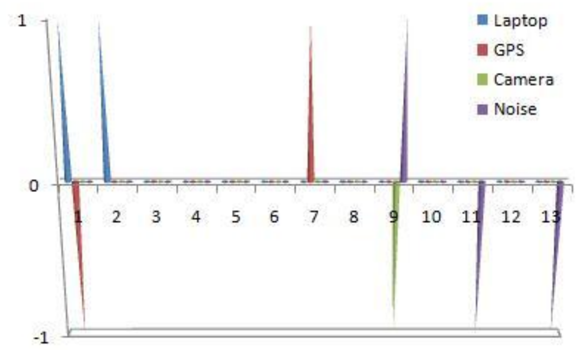

Figure 3. Individual engagement to fulfill the group's task

Later, as shown on the previous paragraph, the other group members familiarize with the data collection procedure and the coordinative role of the netbook student gets redundant. The spikes in PDCs 7 and 9 represent situations where one student mediates between different interests within the group and thereby ensures the continuation of the data collection.

From PDC 5 onwards it becomes obvious that the sound recorder student reduces the time where he is collocated with the other three group members. He joins the group as the last person, stays for the data collection and leaves immediately afterwards. This tendency intensifies in PDCs 11 and 13. The sound recorder student doesn't collocate with the group during the GPS recording and thereby inhibits the required connection of GPS and sound data which is the central idea of the data collection. In addition to this individual misperformance of the sound recorder student there is no other student who reminds him or the whole group to the mandatory connection of GPS and sound data.

5. DISCUSSION

The above findings suggest that 1) there is no equal distribution of the individual student's engagement within the group and 2) they do not reflect on what data they collect in the fieldtrip. Even though the data collected by the sound recorder student is essential, he does not seem to realize it since sound recording is continuous and his task does not really involve interaction with the sound recorder. He therefore shows a pattern of disengagement as he discovers that there is no need for him to collocate. The fact that the other students are not engaged indicates that they are not fully aware of the consequences of the data logging to happen in different coordinates.

Students' discourse also indicated that even if they were engaged with the task, they did not reflect on that the task was about or what the data collected could mean. Their talk was either very specific to coordinate the task, e.g. countdown or irrelevant to the task. This leads to considerations around how could reflection in the field could be supported. A suggestion relates to the role of the researcher who chose to be an observer-participant rather than a scaffolding agent. Rogers (2008) talks about the changing role of the facilitator who could prompt and support the children. Even though this could lead to a personalized version of the in-situ experience, it is a design choice that needs to be explicit to the task. Rogers and Price (2008) also pinpoint to the need for immediate visualisation of the collected data. Being able to visualize continuous findings on the spot is a challenge that was overcome later in the intervention but not for the fieldtrip. Instead, the students visualized their findings right after their data collection task and while in the fieldtrip rather than waiting to go back in the school class. However it shows that with real-time visualization students can see the consequences of the actions in real time and run immediate "what-if" experiments (Anastopoulou & Sharples, 2010). Alternatively, the role of one of the group members could be re-considered and they could become the critical friend or the interrogator of the group members so that students are always aware of their actions on the spot.

6. CONCLUSION

By studying students' collaboration during a data collection task in a fieldtrip, we identified that students are not equally engaged within the group and that they do not reflect on the fly. To address these issues we propose that effort towards supporting reflection in the field needs to be given and suggestions relate to providing real-time visualization while in the field, re-considering the degree of participation of the researcher or the role of one of the group members.

7. ACKNOWLEDGEMENTS

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Challenges for Mobile Learning - Designing for Learner Generated Authenticity

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Abstract

In this paper, we describe a project on Mobile Assisted Language Learning for adult second language learners. The project has designed a mobile learning environment that supports collaborative production and sharing of learner generated authentic content. The project is in a pilot phase and the paper reports the preliminary findings which indicate a high level of learner ownership, engagement and motivation.

Keywords

Mobile assisted language learning, authenticity, learner generated content, designs for learning, lifelong learning

1. INTRODUCTION

One of the big challenges for second language learning is how ICT and mobile media can be used to mediate or create connections between the formal classroom setting and a more informal learning environment (Bo-Kristensen et al. 2009). In second language Danish learning, it is important to create a connection between, for example, the teaching of Danish and a real life setting as reflected in the environment where Danish is being used. A keyword in second language pedagogy is authenticity (van Lier 1996), since the communicative appropriation of language must draw on the authentic and experiential input from the real life of the learners.

In adult education and lifelong learning, authenticity, relevance and meaningfulness are key factors in the learning process (Jarvis 2006). Most Mobile Assisted Language Learning (MALL) until now has focused on delivering content (Kukulska-Hulme, A., and Shield, L. 2008) rather than having the learners engage in using the mobile media to collaboratively produce and share their own content.

Even though there is relatively easy access to the use of ICT in second language learning, the reality is that it is rarely fully integrated in the formal learning environment.

Therefore one of the challenges in second language learning is to identify effective ways of using new media, including mobile media, to acquire relevant and authentic language. (Bo-Kristensen et al.2009). Mobile learning may afford a broader perspective on how to involve the learners in authentic productive activities. It may also raise a number of questions concerning the design of the learning contexts, the affordances of the mobile media (Gjedde 2009), as well as the competencies needed by the teachers and learners in order to take full advantage of the learning potentials of the media.

The production of meaning in language learning is a key issue, which may not always be supported by language learning based on rote learning designs or one-way communication. Authenticity in second-language learning is usually defined by the teacher through the learning materials that are employed. But using mobile media allows for learning designs that provide support for user generated authenticity in the learning situation. David Hull argues for the importance of contextual learning that : "According to contextual learning theory, learning occurs only when students (learners) process new information or knowledge in such a way that it makes sense to them in their frame of reference [....] This approach to learning and teaching assumes that the mind naturally seeks meaning in context--that is, in the environment where the person is located--and that it does so through searching for relationships that make sense and appear useful." (Hull 1993) Lave and Wenger (1991) suggest that learning is a social process situated in a specific context, and that the learning environment and social setting is crucial to the construction of knowledge in what they term communities of practice.

The hypothesis of the project, which we will present and discuss, is that the process of language learning is supported by being centered in a context that is authentic and provides relevance for the learning of the language. Furthermore it is argued that a learning design that provides for learner generated authentic content provides ownership and ensures the relevance that can strengthen the learning process in terms of motivation and engagement.

2. BACKGROUND

There are different ways of looking at the connection between the classroom and the outside world. In second language learning and teaching, teachers try to create a connection between formal classroom activities and the informal activities that students use in their everyday and workplace environments. This is discussed in Bo-Kristensen et al (2009). The use of mobile devices can be understood as mediating artifacts bridge the domains. Second language learning research uses learning theory inspired, e.g., by Atkinson (2007) In general second language learning research several models are offered: information- and system theory-based, hermeneutically- and phenomenological-based models .These models have 3 central processes in common (Bo-Kristensen et al 2009):

1) Prior knowledge, 2) Attention and 3) use.

3. PROJECT AIMS AND DESCRIPTION

Throughout Europe, there is a need for skilled workers. This is also the case in Denmark. Today, many of these come from other EU countries. They need to to learn Danish and acquire knowledge of Danish workplace culture in order to function well and efficiently in a working day in the company. There is need to think in new, flexible ways to train these employees in the best possible manner. Often, companies find it difficult to do without staff leaving on in-service training in a busy weekday. And it can be difficult for educational institutions to offer targeted in-service training for individual enterprises. Therefore, there is need to think in flexible (mobile and Internet-based) practice-learning training where students can learn in groups across companies.

This paper is based on experiences from an ongoing m-learning project. The project is a three-year (2009 - 2012) project on Mobile-Assisted Learning financed by the European Social Fund program, and involves educational institutions and companies in Region South Denmark. The project aims at developing innovative and growth-enhancing mobile assisted training for employees of small and medium sized enterprises (SME). Future, globalized labor markets require constant development of employee skills. In Region South Denmark, there is a number of educational institutions that can provide highly qualified language courses. But educational institutions as well as enterprises are very aware that life-long learning is closely linked to when and where learning can take place. This is because the enterprises may find it difficult to do without employees for longer periods of time. Furthermore, there needs to be effective links between what takes place in the informal learning environment and what is needed in the work-place in practice. In relation to these issues it is the aim of the project to explore, design and implement mobile based learning scenarios. As a point of departure we have based these scenarios on the design of different types of activities. We have defined three types of activities in the design for learning with mobile media. (Fig.1)

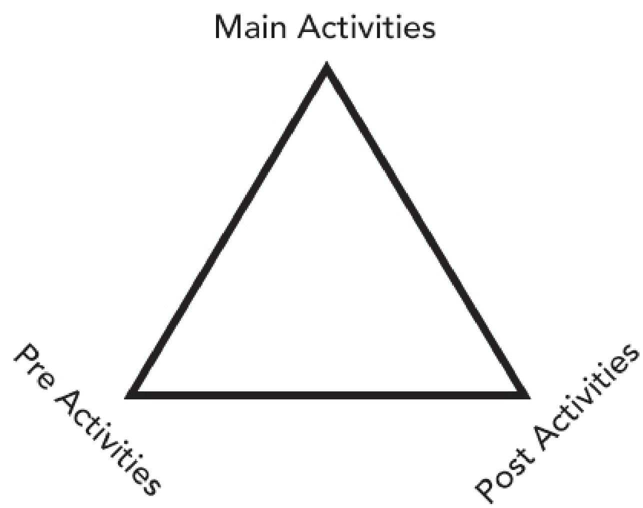

Fig. 1. A preliminary model of learning activities

The “Pre-activities” includes establishing a joint framework for the learners, based on their prior knowledge of language, in a formal classroom setting where the students have a dialogue on the theme, and are being prepared for how to use the mobile to record situations from their everyday and working life, using the facilities of the mobile for voice, video and text recordings. They are also instructed on how to upload it to the dedicated project server, which makes it available for fellow learners and the teacher. The main activities consist of "research" into work-life language and language situations, where the mobile is used as a source of registering phenomena. Also it involves communicating these phenomena via mobile media to fellow students and the teacher, with the focus on establishing the learners attention. Finally, post-activities take place in the formal classroom (or the extended net-based classroom) where students get at chance to reflect on and use the phenomena registered by the mobile phone.

4. METHODS

The project is at a pilot stage, and is being developed in close collaboration between educational providers and enterprises, and involving researchers in the design and reflection process. Partners in the project include 4 language course providers, a university and private enterprises. Until now, one pilot course for teachers and two pilot courses for students have been held. An action research approach is employed, in which the ten teachers who are involved in the project, contribute to the development of the educational design as well as making observations and reporting back. There are also two ethnographical studies of the groups of students using the mobile devices, that are fed into the design process.

5. PRELIMINARY RESULTS

Returning to the issues of learner generated contexts and authenticity in relation to mobile lifelong learning scenarios, we will point to some preliminary findings: Based on the observations from the teachers, one of the interesting points so far is that they report on having observed much higher levels of motivation, engagement and ownership by the learners, and relates that to the learners own registration and production of authentic learning materials that are distributed among the community of learners, using the server.

However, the positive impact of this learning approach seems to be linked with the background of the learners and the competencies of the teachers in relation to engaging the learners in the production of authentic materials.

The project so far has produced learning scenarios using mobile media production as a means to learner generated contexts and authenticity in second-language learning, and to produce material to situate conversations.

An important factor in this has been the development of tasks that engage the learners in authentic productive activities. The project has developed dual platform supporting mobile as well as PC access, in order to provide access for learners and teachers in the most appropriate manner. The aim of using the mobile in the learning situation is to provide a resource that enhances the motivation for the learners to explore their own authentic language usage in the context of their working place.

The project has developed a dual PC- and mobile-based platform. The aim is to provide access for learners and teachers to produce and read on the most appropriate platform at any given time. The intent for integrating the mobile is to provide a potentially engaging learning tool that is supposed to strengthen the motivation to explore the learners` own authentic language practice in a work context.

For some learners and teachers, the PC-platform is a more appropriate way to prepare and process tasks and produced materials. The PC-platform is meant to be used supplementary to the main activities, to explore and register the situations and artifacts which the target language is linked to.

There are different types of tasks which are all distributed via the platform, which also allows for interaction between the learners and the teacher.

An example of a task is for learners to find and document three warning- and safety signs at the enterprise where they work, and to upload them to a joint gallery for the class.

The learner has a couple of days to choose the signs from a variety at the working place. Then, there is a processing of a language content in relation to the learners own production of photos, as well as the total class production. This can, for instance, be done through commentaries to the photos.

Another example of a more open task would be to ask the learner to take 3 photos or produce 3 short video-sequences (30-45 secs.) from their working environment.

While the process is similar to the previous task this type of task provides possibilities for more personal choice and creativity. The learner can choose to see the fellow learners` productions (video, photo and text)via the mobile or the PC-platform. Especially at the beginning of a mobile-based course it can be an advantage to access the photo/video gallery via the PC-platform, which provides a greater overview. Both task examples represent a learning-design in which the learner produce authenticity - that is authentic content as well as authentic, relevant and meaningful learning experiences.

At the same time the mobile-based courses represent a way of creating connections between the formal and the informal learning environment. In this way the learner mediates across environments using the mobile technology, in a process of genuine collaborative learning.

6. DISCUSSION

One of the questions this project raises has to do with whether this approach to learning design actually has affordances for creating an experience of greater authenticity for the learners. This approach has to be related to the competencies of the teachers in relation to offering relevant linguistic themes and tasks, depending on the background and prior knowledge of the learners. While the teachers already generally possess competencies regarding evaluation of learners and personalization of their teaching, combining it with a learner-centered approach calls for further development of skills and competencies regarding the special challenges that designing for mobile learning activities poses. Especially, when designing for productive activities one has to bear in mind the teachers` and learners` roles and competencies towards the staging and evaluation of the production of authentic content.

7. CONCLUSION

Returning to the issues of authentic learning, learner diversities and teacher` competencies in relation to mobile lifelong learning scenarios, we will suggest some conclusions based on the preliminary results. The project is developing a design for learner generated authentic content, in order to support the process of life long language learning, and engaging the learner. Furthermore, this approach seems to support the ownership of the learner and provides the needed relevance of the material.

We developed a learning design using three different types of activities and in the pilot studies found that the motivating and engaging qualities of using the mobile media as a mediating and productive tool were prevalent.

Further research in the project will address issues relating to the design of the mobile learning environment in order to enhance the affordances for learner generated authentic content.

Further research will also address the issues of which teachers` competencies are needed, in order to stage and evaluate the learning process of a very diverse group of learners.
This learning design offers a framework for the learners in which they can produce authentic materials that are relevant. In traditional second language teaching , authenticity is mediated by a teacher using linear media. The concept of learner generated authenticity using mobile media is very promising in relation to developing engaging learning designs for new media.

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Mobile Learning for Lifelong Learning projects in the Italian context

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Abstract
In this paper, we describe the state of the art on the use of mobile devices for lifelong learning initiatives in Italy. The paper is based on the research work done in the framework of the European project MOTILL (MObile Technologies in Lifelong Learning: best practices). Some exemplary projects on lifelong learning involving mobile technologies in Europe have been identified and analyzed according to three dimensions: management, pedagogy and policy. In this paper we report on the Italian context as emerged by the study of the three Italian projects.

Keywords
Mobile learning, lifelong learning, mobile learning projects.

1. INTRODUCTION
This paper will be devoted to discuss selected mobile learning experiences in the Italian context. This discussion was one of the outcomes produced during the European project Motill (MObile Technologies in Lifelong Learning: best practices). This project was aimed to construct a common framework involving educational research centers and the principal public and private agencies, engaged in the sector of learning and training, to support the use of the mobile technologies in the Life Long Learning (LLL) context.

The main aspects related to the theoretical and methodological approach developed during the MOTILL project are out of the scope of this paper. Instead, some specific questions that characterize the implementation of mobile learning initiatives in the Italian context will be highlighted. The importance to contextualize any discourse about mobile learning is central to this paper. This statement has many fundamental implications. For example, it means that mobile learning cannot be examined without taking into consideration political and socio-economic situation, global and local educational policies, diffusion of specific technologies as well as competences and skills to use them properly.

Therefore, mobile learning will be analyzed against the "ecological landscape" of educational policies (Weaver-Hightower, 2008) in Italy. In particular this approach requires identifying *actors*, *relationships*, *environments and structure*, and *processes* involved in the constitution of any complex ecosystem. Starting from three real experiences of mobile learning, examined during the MOTILL project, we point out some components characterizing the ecology of educational policies in Italy.

In the framework of the MOTILL project, the Institute for Educational Technologies of the Italian National Research Council has selected three mobile learning projects in Italy, by means of structured interviews with the project coordinators. Interviews have been structured in such a way to gather data on 3 analysis dimensions: management, pedagogy and policy; 18 key features for the three dimensions have been identified by the research team of the MOTILL project. Finally, ethical considerations have been analyzed too.

In this paper, the data gathered during the interviews will be interpreted in an ecological perspective (Firestone, 1989; Ball, 1998; Cash et al., 2003; Barab and Roth, 2006; Weaver-Hightower, 2008): for each mobile learning experience, we describe the specific niche within an ecology that the experience has contributed to define and in which, consequently, it has to be situated.

Consequently, it will be possible to point out some considerations about relevant educational policies carried out in the Italian national context.

2. THREE MOBILE LEARNING PROJECT IN ITALY
The use of mobile technologies in formal, not formal, and informal educational contexts is a relatively new topic in the Italian landscape, and this is in contrast with the fact that these technologies are deeply pervasive in the Italian social panorama. Often, in newspapers, these technologies have been discussed in relation to unfair and bullying behaviors, or to the diffusion, thanks to the activity of text messaging, of peculiar shibboleths between adolescents (Caron and Caronia, 2007). But rarely, one can read something about opportunities offered by mobile technologies in education and learning (Traxler, 2010).

This situation defines a peculiar ecology in which predation relationships prevail. The main actor, the student, is considered principally as a potential prey, and mobile technologies as the predators. Often, the agency, that is the power to act within ecology, seems reserved to technology, and the prey is described as unable to resist to the power of that.

In this landscape, some processes are activated from educational agencies, such as schools, academics, VET (Vocational and Educational Training) centers, and from policy departments, at national, regional, and local level. Regarding to this, a double movement can be observed. The first movement is conservative, it is aimed to preserve the environment, reducing resources consumption, and using technology as a facilitator. The second movement is addressed to conversion and adaptation, the rationale is the necessity to cope with a dramatic change; here the technology is deemed as a lever able to push the educational system in a new direction.

This double movement characterizes a plurality of educational policies aimed to integrate ICTs in learning processes. This justifies also the tendency to think of the use of mobile technologies such as an opportunity to tackle some relevant problems in the Italian educational landscape: Italy's poor performance in various indicators of educational achievement (Polesen, 2010); the long lasting permanence of students at Italian universities; the new migratory wave in Italy.

The three mobile learning projects discussed in this section, have been conceived with the objective to tackle exactly these three different issues.

2.1 MoULe

The MoULe (Mobile and Ubiquitous Learning) is an online environment for collaborative learning; by integrating smart phones and portable devices, it enables educational activities based on the exploration of a geographical place. The system includes specific functionalities to search and access information spaces, to communicate and to annotate places according to their geographical coordinate. Data stored in the system are enriched by the information concerning geographical localization, so that the system provides users with information specific to the place they are visiting. Teachers can use MoULe to design educational paths, monitor users' activities in real time, and evaluate quantity and quality of interactions among users (Arrigo et al., 2007).

This technological environment is aimed to support high school students using context sensitive handheld devices in collaborative knowledge construction. The mobile technologies have been used as tools able to sustain students' creative work, while they are engaged in informal activities. So, technology emerges as a new resource in the educational policy ecology; it provides a suitable help to tackle the problem of the poor performance in the educational achievement, moving the focus from school to context, from the individual to the group, from the scholastic curriculum to experiences in real life.

The transition between formal and informal learning was promoted by the design of experimental activities alternating onsite and classroom learning, and by the learning environment created which was accessible through the use of both mobile devices and computers. During these learning experiences, the students can discover different sources of information, different ways to extract, elaborate, construct and store the knowledge. This transition, from a mere notional knowledge to a situated learning experience, is probably one of the most important transformations needed or students to support their learning throughout a lifetime.

This is also evident in the pedagogical approach that authors have adopted in designing the technological environment. In fact, the informants have declared:

> *In this project a model for mobile Knowledge Building Process was defined; on the basis of this model. According to the social constructivism paradigm, knowledge is not transferred from teachers to students, but is the result of collaborative activities.*

As result of this learning experience, the students acquired competences in using online educational tools, particularly applications which promote processes of collaborative knowledge construction and improve their abilities to work in a group.

The political objective is also corroborated by the informant's consideration:

> *The MoULe project provides teachers and schools with tools which enable them to exploit the educational potential of onsite learning activities.*

In the context of the MoULe project, the practice of the mobile learning has had an impact on the distribution of the roles within the class, new social ties are been established during the experience, and students have found new ways to learn and work. This project seems to claim new political actions needed to spread similar practices in wider contexts, creating networks between different schools, integrating learning activities with other social and cultural initiatives. A new educational policy landscape will have to settle down because the necessity to introduce new technological tools at school could be taken into account to obtain a greater involvement of students and also to verify the didactic efficacy of these new apparatuses.

2.2 Federica

Federica is the e-Learning of the University of Naples Federico II, it was developed to offer free access to the academic knowledge of the university, with the free offer of educational materials and a structured guide to the enormous informative patrimony already available in Internet. The interface of the web learning portal of Federica use a modular approach that combines simplicity, flexibility and high technological quality. Using this portal students can consult study materials for university courses in e-Learning (also available in podcast format), at any time, with extraordinary wealth of contents organized in training modules with different media format. The intention is to provide better support to students in gaining access to university knowledge content, in particular, this support is targeted at students who are behind with their studies, to those off campus and to foreigners. Federica has received more than two million hits in its first year, an indication of a significant user base, has not linear effects on the ecology of learning at university.

If the initial objective of Federica was to involve people in university education and to make knowledge within the university easily accessible to all, now this platform makes university courseware knowledge accessible not only to students enrolled in courses but to everyone. Informants put on evidence that considerable interest in Federica has been shown by working professionals, postgraduates and young people interested in having access to a university. Moreover, students using platform come from different areas and regions, from Albania, ex-Yugoslavia, Greece, the Middle East.

So, if at the start of the initiative the aim was to focus on the local territory, then this was followed by the natural evolution of Federica towards international users because it aroused interest in various regions of the world in university courseware.

Federica initiative seems to boost emergent processes; these processes are characterized by the appearance of new ecologies in which old problems look for new solutions. To manage such processes, different levels of policy have to be involved, and so it is not strange that:

> *The initiative has been strongly promoted by the dean of the university in order to reorganize and improve the structure of e-learning at the university. Right now local politicians, are showing a lot of interest and involvement and are, working to support the initiative financially as well as politically.*

Regarding the use of mobile technology, this varies from a soft approach, via audio podcasts, designed more for the dissemination of academic content, to a more sophisticated approach This was designed mainly for interactivity, via a web interface and smartphone, e.g. iPhone or similar, that has a higher cost and is more commonly used by professionals workers than by students. The intention is to introduce the student to the use of mobile technologies in a progressive manner, allowing even those who are economically disadvantaged to be able to use low cost resources.

2.3 Ensemble

The main objective of the ENSEMBLE project is to test innovative and multi-modal training approaches to support integration and active citizenship for young and adult migrant groups in accordance with the 2003 Progress report about Democratic values, participation and active citizenship education. New mobile communication tools represent strategic instruments for increasing and improving the participation of populations at risk of exclusion, regardless of differences of age and education. The participation of adults and young people in the ENSEMBLE project emphasizes the use of open, flexible and innovative learning methods responding to learners' needs and current habits (use of mobile phone and podcasts).

This project is strictly linked to an ecological political landscape, fixed at European level. In fact, the general background of the ENSEMBLE project proposal is provided by the European immigrant integration policies and by the recent Communication "European i2010 initiative on e-Inclusion - to be part of the information society" in which the Commission underlines the role of ICT in providing the conditions for everyone to take part in the information society by bridging the accessibility, broadband and competence gaps, accelerating effective participation of groups at risk of exclusion and improving the quality of life.

In the last five years this landscape has been established in various documents, and the European Union underlines the relevance of the media which has considerable responsibility in its role as an educator of public opinion.

At national level, the management of the educational policy for integration has been an increasing issue of last few years. In Italy, the national Parliament has ruled the phenomenon of immigration by means of various laws: starting from 1986. In this paper, we cannot examine the educational policies arisen from these laws (Ponzo, 2009, table 1 at p. 18), but it is important to highlight as the ENSEMBLE project work over a very relevant problem: if at current time now the immigrant students between 15-24 years old are only the 9% of the total, in the 2050 they will be the 38% of the total (Cipollone and Sestito, 2010, p. 32).

The ENSEMBLE project proposes a new approach to this topic using mobile devices. The rationale is that the steadily increasing availability of these devices, their versatility and mobility are heightening interest in the use of such instruments in disadvantaged contexts, where the Internet connection is not available, but there are mobile phones; in fact, low-cost mobile devices offer opportunities for reducing inequalities at a global level.

ENSEMBLE intention appears to want to establish an environment where cooperative relationships prevail, this is obtained by combining the development of an innovative didactic methodology with the use of very common mobile technologies.

The experimentation has been undertaken in two different areas in Europe: the town of Prato in Italy, and the district of Yvelines in France, on a sample population of different national/ethnic origins. The practice was mainly initiated by municipalities, since these stakeholders were already making big efforts to foster social inclusion of immigrants. The target group of the project were students of 13-15 years old (second generation immigrants) and the students' parents (first generation immigrants).

Informal learning is present for both the target groups: students and adults. Actually, adult learning occurs almost entirely on an informal basis. Specifically for young students, MP3 devices allow young students to move from formal learning strategies in the classroom, towards informal learning opportunities occurring outside the school. Regarding to this, informants declared:

> *Further investigation would be necessary in order to evaluate the role of these informal learning moments in the whole learning process; in addition, these informal learning occasions are strictly related to something occurring in a formal educational setting, and are sometimes dependent on the activity performed in the classroom*

The transition between formal to informal learning moments is a key pedagogical idea in ENSEMBLE. In this way, the project wants to stimulate processes of adaptation and conversion. In these processes the change can be dramatic and actors have to adapt to these altered environments.

3. CONCLUSION

The relation between mobile technologies and lifelong learning in Italy seems to push educational policies in direction of a peculiar ecological landscape. In particular, technologies and methodologies can cooperate to create a environment where new processes can emerge spontaneously. These processes could boost a dramatic change by means of the overcoming of traditional boundaries between formal and informal contexts for learning.

In this perspective, the researchers involved in this field have underlined the opportunity to introduce the ICTs at school as tools to face some relevant problems that are slowing economic and social development. In this paper we have analyzed three Italian mobile learning projects and we have highlighted that each project was aimed to face a specific difficulty: poor performances of students in problem solving and in creative thinking (MoULe); long lasting period of permanence at university (Federica); integration of immigrants at school (ENSEMBLE). The choice of the specific problem to face is not random; it reflects a specific vision about technologies such as facilitator or as lever in a cooperative relationship.

However, the educational context in Italy is also characterized by others problems. For example, inequalities in performances between geographic areas, lack of a quality assessment system in education, scarcity in adult literacy; and different ecologies have been proposed to cope with them. The theory of human capital (Becker, 1964; Cipollone and Sestito, 2010), for example, introduces a more competitive environment, in which the policy makers have to manage the scarcity of knowledge resources, the distribution of incentives, and the control of the quality of the whole educational system, for example by means of introduction of some international system for assessing skills and competences.

This paper is aimed to better understand the opportunities offered by the mobile technologies in lifelong learning. Regarding to this, the main suggestion is the when a new technological and methodological environment is designed, it is extremely important to take into consideration the entire ecological landscape, evaluating also the national educational policies that the use of mobile devices can encourage.

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Posters

Mobile Learning for Higher Education in PBL Environments

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ABSTRACT

This study is about the design and development of mobile technologies to support students' collaboration in groups during project periods in a problem oriented and project based learning environment. The study will take departure in the group work of students in the faculty of Humanities, Aalborg University.

Keywords

Mobile Learning, PBL, Collaborative Learning, PLE, Integration

1. INTRODUCTION

This project concerns mobile technologies as a means to support learning in higher education with a particular focus on problem oriented and project based learning environments. The project aims to use web based and mobile technologies to improve learning and collaboration, and the research will focus on learning scenarios within higher education which adopts a problem and project based learning approach often called the Aalborg PBL model (Kolmos, K.Fink, & Krogh, 2004). Aalborg University has employed this particular PBL model since 1974, which is also referred to as problem oriented project pedagogy (POPP) (Lone Dirckinck-Holmfeld, 2002). In POPP, the students themselves define the problems to engage with and also how to organize this project work; theoretically, methodologically and practically, but work closely with a project supervisor (staff). This is where POPP differs from traditional PBL (problem based learning)(Tolsby, Nyvang, & L. Dirckinck-Holmfeld, 2002). Students in Aalborg University form groups, define problems and collaborate within team to work on the project with facilitation from the supervisor.

Students in Aalborg University have to do group projects every semester and the projects are very important for them because the project will be assessed and account for approximately half of their ECTS points. Therefore good collaboration skills and tools are critical to develop a high quality project. Within some environments, Aalborg University has experimented with and used ICT tools to support students' project work (Kolmos, K.Fink, & Krogh, 2004; Tolsby, Nyvang, & L. Dirckinck-Holmfeld, 2002) and there are online and blended master programmes applying a PBL approach (such as Master in ICT and Learning (MIL) and Master in Problem Based Learning (MPBL)). However, research, experiments and developmental work on utilizing mobile technologies in relation to this particular problem based learning approach is less developed.

The aim of the study is to design and develop mobile technologies which can improve the quality of students' collaboration and project work. The overarching research question the research will address is "How can mobile technologies increase the quality of collaboration and group work in PBL environments?" Furthermore the research project will address these questions.

- What are the benefits students can get from mobile learning in a PBL environment?
- How do students currently use technologies to support their collaboration and how can mobile technology be used to enhance the collaboration in project?
- How do mobile technologies change the way students learn and collaborate?

1.1 Trends within learning technologies

Recently, ideas of Personal Learning Environments (PLEs) have attracted some attention, and some imagine these as replacements of the traditional institutional Virtual Learning Environments (e.g. Blackboard, Moodle or other VLEs/Learning Management Systems), whereas others argue that PLEs can supplement or extend the roles of existing VLEs. In a VLE, some argue, teachers organise the tools and structure dialogues (Crook et al., 2008, p. 36), whereas PLEs aim at supporting ideas such as: learning is ongoing, takes place in many different contexts and situations, and that the individual should play a central role in organizing and producing their own learning materials. Therefore, in a PLE management and personalisation of technologies is also part of the learning process (Attwell, 2007, p. 1). Some therefore argue that VLEs are hierarchical, teacher-centred and unable to effectively support student-centred, collaborative learning, whereas others argue that VLEs and PLEs can support and supplement each other (or fulfill different purposes) (Dalsgaard, 2006). We do not mean to side in this debate, but rather to point out that (broadly speaking) the calls for PLEs and educational uptake of current social technologies seem to revolve around supporting increased personalisation, ownership of tools, and control over the learning environment for students.

In relation to this the broader technological trend seems to be to develop general integration frameworks that allow users to choose learning tools by themselves; then integrate and use all those tools through the integration framework interface. These are also the intentions of the application we aim to develop as part of this research project and Figure 1 shows a sample scenario of such a system, which represent some of our preliminary ideas for a mobile application to support students' collaboration in groups.

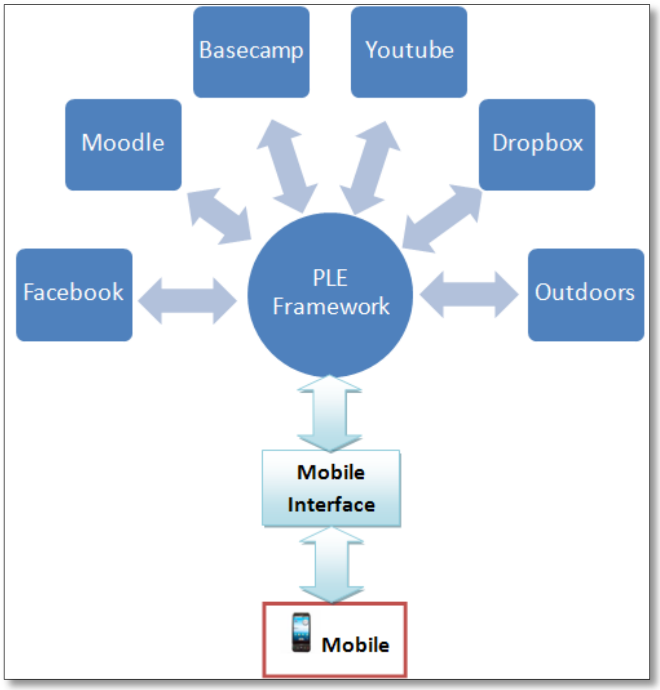

Figure 1: PLE Framework Example

Figure 1 shows a sample scenario where a group of students want to use a PLE framework to support their group collaboration as part of their project work. For example they might want to use Facebook as community tool to communicate within their group, but also want to use the Moodle system which is provided by their faculty, as to get news relevant to their project and course work. They might want to use Basecamp as project management tool, and to use Youtube for sharing video clips as resources in the project. Furthermore, they want to use Dropbox as a file sharing tool and they use e.g. cameras and other tools (e.g. geo-tagging or audio recorder) to capture and share information during field work (e.g. when collecting data). The main idea is that they can integrate these tools in their PLE framework and the framework will provide mobile access features so they can interact with the system at any given time and place from their mobile phone. However, these are tentative ideas which will need to firmly grounded in theoretical and empirical work, as we shall outline in the following.

2. METHOD

The research will start from theoretical study which focuses on problem oriented and project based learning, Web 2.0 and Collaborative Learning. The research design is to engage in empirical studies, such as interviews, group-work observations and also create a survey for students in faculty of Humanities. The aim of the survey is to get more information about how students collaborate and work together during project time, but also about students' general use of technology. After the empirical study, we aim to conduct a workshop where students engage in developing design prototypes. On basis of the prototypes the researcher will develop the system. After the system development, it will be evaluated by groups of students.

We are now 5 months into the research project, and particularly the main author has done some empirical studies; included interviewing students about collaboration within their group during project periods, observing brainstorming sessions where students negotiated and discussed their project topics or ideas, and finally formed their smaller project groups based on their common interest. In the near future, we aim to design and launch the survey about ICT use in projects, and observe more closely their actual work in groups.

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Mobile Device Usage Patterns and Their Impact on Instructional Design

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Abstract

This paper provides an overview of mobile device use in daily activities and for learning. It focuses on a survey that investigated the types of mobile devices used by college students and patterns of use. A brief discussion follows on how the findings can enhance the design of mobile learning.

Keywords

Mobile devices, usage patterns, instructional design

1. Mobile Device Usage Overview

Globally, societies are becoming saturated with mobile, personal, portable, and wireless devices (Traxler, 2010). In every sector of education, and across both developing and developed nations, the use of mobile devices (MD) is gradually diversifying and increasing (Traxler, 2007). This paper describes a survey of college students' MD use to inform m-learning pedagogical practice and learner-centered instructional design (ID).

Ahonen (2010) suggests the mobile industry has now 4.6 billion active subscriptions (68% of the world's population). Due to their portability and convenience, their multimedia capabilities and personalization, mobile technologies can take learning out-of-classrooms and into real-life contexts. "Mobile devices have become commonplace tools, yet little is known about how individuals use them in their teaching, learning, work, and leisure" (Kukulska-Hulme & Pettit, 2009, p. 135). In the context of learning, networked mobile technology offers portability regardless of the location for both formal and informal learning, and is valued for personal communication (Oksman, 2006). Peters (2007) argues that the education and training sector needs to be informed about MD usage related to the potential of m-learning and future trends for pedagogical practice.

A number of studies have examined MD use in education. Oksman (2006) posits that "the actual use contexts and user experiences of mobile devices among different generations in their daily life can provide important insights on how to improve design and services associated with the technologies" (p.1). Kennedy et al. (2006) assert that research is needed to determine the specific circumstances under which students would like their 'living technologies' to be adapted as 'learning technologies'. Corbeil et al. (2008) argue that to assess students' readiness for m-learning, research should be examining the MD that are currently being used in addition to the activities learners are engaged in while using these devices. Pettit and Kukulska-Hulme (2007) claim that uncovering existing patterns of mobile use may be beneficial to determine the role of MD in engaging learners in learning conversations but should not preclude educators from seeking out other opportunities for learners to adopt a new device or different type of MD use.

2. College Students' Use of Mobile Devices

To improve the ID of m-learning incorporating a learner-centred approach, it is vital to know the types of MD being used by students and patterns of use. This information can provide insights into the technological affordances and limitations as well as users' interaction preferences with others, with the device, and the content. Therefore, the needs analysis phase of an m-learning design project encompassed a student MD use survey. A main goal of the project is to design mobile-assisted language learning activities which take language learning and practice into the real world. This study compared general college students with the L1[1] and L2 student strata. Findings were comparable for the two groups except the time students devote to activities.

A random sample of 527 students was asked about their MD type and use. While 521 (98.9%) respondents had their own MD, six students (1.1%) did not possess a MD. 34.9% owned multiple MD including one or more smartphones, mp3 players, and game consoles. Amongst all respondents who own at least one MD, 2.5% did not have a mobile phone, but had an iPod or an iPod Touch or both. The majority use a Smartphone. Figure 1 illustrates the phone brands used. The Smartphone's rich capabilities including camera, mp3 players and voice recorder are constructive multimedia tools for mediating learning and communication, particularly in a language-learning context.

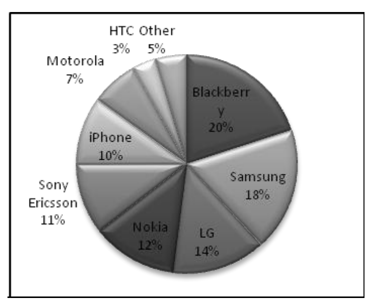

Figure 1: Mobile phone brands – students' responses

[1] L1: speakers of English as their first language; L2: speakers of English as their second language

How m-learning can be realized depends on the MD features, user connection, and network access. The survey inquired about the data plan subscriptions (see Figure 2).

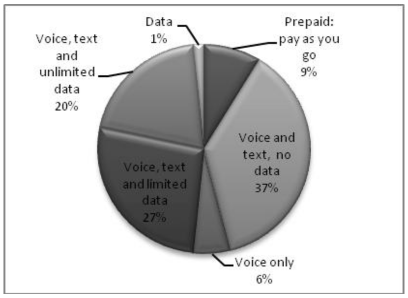

Figure 2: Data plans students subscribe to

52% of students subscribe to a phone plan with no Internet access while 27% have a limited data option. Phone access is limited for students commuting via the subway. Those who spend up to four hours/day on the public transport (see Figure 3) could benefit from dead-time learning activities. However, such learning may be devoid of interaction which is vital for effective language learning. Students identified commute time as the most opportune time for m-learning.

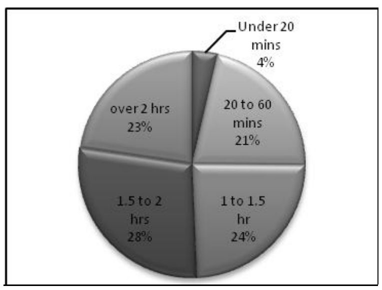

Figure 3: Commute time (per diem) for students

The findings indicated that texting, phone talking and music listening are the most popular activities, with the average MD time for L1 students (172 minutes/day) exceeding the L2 average at 167 minutes/day (13% of respondents spend more than 5 hours/day on their MD). While L1 students identified texting as their main activity, the L2 group prefers voice-based communication. The latter group also devotes significantly more time to Internet browsing (see Figure 4).

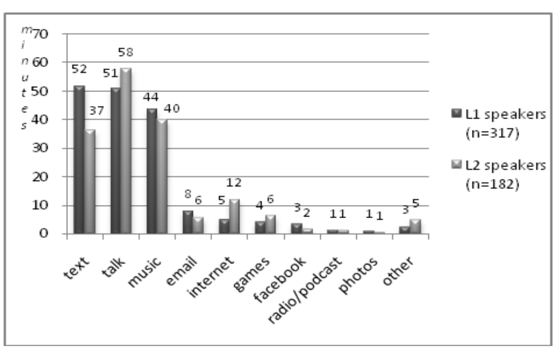

Figure 4: Average time per diem spent using MD features (in minutes): L1 vs. L2

Further research is needed to establish the roots of these discrepancies; nevertheless, these findings provide important insights into the mobile sub-culture of the college students.

3. Conclusion

From this exploratory study on college students' MD use, we move onto learner-centered instructional design informed by pedagogy and an enhanced understanding of our students' needs and preferences. Nevertheless, as Pettit and Kukulska-Hulme (2007) suggest, we will not preclude learners from seeking out other opportunities to adopt a new device or different type of use. We will indeed encourage learning which is enriched by engagement and experimentation. The uniqueness of this setting including the varying students' needs makes it difficult to generalize our findings to other m-learning contexts. We invite discourse based on what solutions would be salient in this and other comparable mobile learning context.

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Digital Herbarium Project: An educational experience integrating computer vision-based techniques in mobile phones

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Abstract

In this paper, we outline a full educational experience based on the application "Virtual Herbarium". This application integrates Computer Vision techniques together with multimedia graphical interfaces, which allow students to create their own herbariums by taking photos of leaves with mobile phones with varied metadata. The experience is enhanced by the use of Machine Learning-based functionality that hints the students about the morphology of the leaves, and the addition of interconnectivity capabilities that make possible the edition of customized databases of local flora. The whole educational experience is oriented to the assimilation of the scientific method in a natural way.

Keywords

Mobile phones, herbarium, interconnectivity computer vision, machine learning.

1. INTRODUCTION

There is genuine need of integration of mobile technologies within educational environments. This need is based on the possibility of taking profit of the benefits of personalization, immediacy, communication and inherent multimedia management that mobile technologies allow, addressing in this way new paradigms of learning. The integration of Computer Vision-based techniques (Forsyth, D.A. and Ponce, (2004)) -which make possible the automatic processing and analysis of images-, and their joint use with Machine Learning-based strategies (*Bishop, C.M. (2007)*)– which allow the inference of higher level interpretation of data-, has not deserved a substantial room for research in the current literature yet. One of the likely reasons for this situation points out to the fact that those centers oriented to the study of computer vision and machine learning strategies, usually, are not institutionally linked to the educational centers, being this typically the case both for higher and secondary/primary education.

In this paper, we outline a whole educational experience which integrates computer vision and machine learning strategies into a mobile device with a twofold aim: On the one hand, the students will use a mobile phone application in a real field study to create their own herbarium by taking photos to the leaves of the trees in their local environment. The students will enrich their learning experience by receiving feedback from the application regarding shape features associated to the leaves, and hints about the type of tree a given leaf belongs to.

One the other hand, the educational experience is enhanced in the teaching room by making the students aware of the underlying technology, mathematical descriptors used for the shape features and the explanation of the scientific method applied. These explanations are used by the students in a previous step to build up a database of the local flora by annotating pictures of leaves, which will be used by the system to provide the feedback hints regarding the type of tree.

2. THE EDUCATIONAL EXPERIENCE

As mentioned before, the educational experience is divided in different stages:

Stage 1: First, the students receive an introductory lecture about the trees commonly available in their local area. This lecture pays particular attention to the characterization of the different types of trees based on all their features (leaf shape, leaf structure, flowers, fruits, twigs, bark, silhouette, etc.) (Clave, A. (1995)), and provides the students with the basic knowledge about the proper naming for the trees.

Stage 2: Next, the students are enrolled in a field study in which they are entitled to take pictures of the leaves and to annotate each leaf with a given name. In this stage, the students are monitored by a teacher who helps the students put into correspondence the knowledge achieved in the classroom with the field experience. After this stage, the students put together all the annotated pictures and this constitutes the project database. This database will be visualized and discussed in the classroom paying particular attention to the intra- and inter-class variability of the leaves –this provides the students with a critical appraisal about the difficulty of characterization of leaves based on their shape.

Stage 3: Third, the students go out again to a field study in which they collect new pictures of leaves, but in this case they provide their own annotation using the knowledge achieved in the previous stages. In order to help the students with their annotations, the application provides a hint about the type of tree the leaf belongs to. This hint is provided by a degree of certainty in a list of top 5 candidates, and this guess is obtained by using the data gathered in the database. The hint is provided by the application in a friendly way to the student.

Stage 4: Finally, the students' herbariums are discussed collectively under the supervision of a monitor in the classroom, and the students' annotations are compared with the application hints in order to assess the performance of the automatic system in a qualitative and quantitative way.

The final stage closes the cycle of the experience, and explicitly presents the scientific method putting it into correspondence with the actual experience carried out by the students: collection of a database, annotation of the database, testing of the methods, empiric evaluation and assessment. As a parallel achievement, the students acquire a fundamental knowledge about the flora belonging to their natural environment, making the students aware of the values of bio-diversity and respect for the nature. The whole process is sketched in Figure 1.

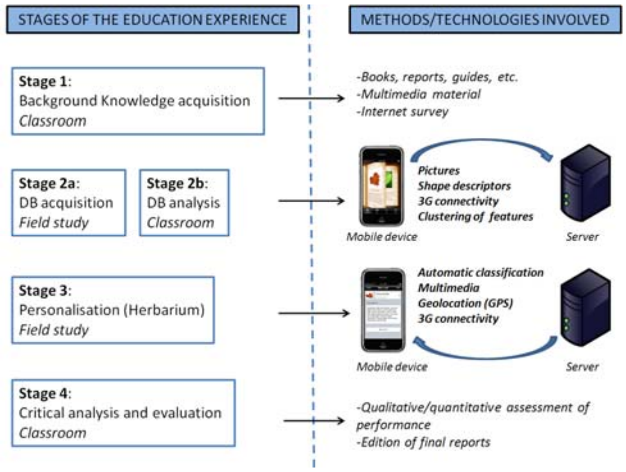

Figure 1: Diagram of the stages of the educational experience, related to the technologies involved

3. DESCRIPTION OF THE APPLICATION

Our application is designed as a graphical interface which simulates a real book –see Figure 2a. For each page, a photo of a leaf is stored. There is a detail sheet (see Figure 2b) in which all the details about the type of tree, comments, and GPS location are edited -in addition a button for the automatic hint for the type of tree is place in this page too. In a different view, we can have access to a map (see Figure 2c) in which each of the annotated leaves is visualized in the original GPS position where it was acquired. The Computer Vision techniques used for shape descriptors include standard background segmentation and MPG7 shape descriptors. The hint for the type of tree is queried to a server in which the database is stored. The Machine Learning techniques used for the classification include algorithms for clustering and near neighbors.

4. PILOT STUDY

Our application is going to be tested within a framework of collaboration between the CVC and UAB, in which different master students have contributed to develop several educational tools. Thus, this framework integrates different resources in a unified educational experience from scientific institutions devoted to the research in computer vision, together with higher education, in order to apply the results in the environment of secondary/primary education. We firmly believe that this approach constitutes an excellent way of including scientific knowledge in a transversal way along the full line of institutions devoted to teaching.

a) b) c)

Figure 2: a) The photo of each leaf is stored in a book page. b) Details, GPS and machine hint appear on the details sheet. c) GPS position of the trees is shown in a new view that approximates the density of the population in a visual way.

5. CONCLUSIONS

In this paper we presented a whole educational experience that shows that the integration of computer vision and machine learning techniques into educational environments constitutes a realistic scenario. These techniques have been traditionally envisaged as not suitable for the educational field, and restricted to specialized research. Our approach is singular from other approaches (Columbia, (2009)) in the sense that it potentially allows the on-line edition of universal databases to which anonymous contributors can upload their findings, and conversely adapt the whole scheme to the particular needs of a classroom. With our contribution we aimed at pointing out the need of integrating into a common strategy the whole universe of institutions devoted to teaching and research in order to provide students with novel, challenging and high quality educational experiences.

6. FUTURE WORK

Further improvements of our approach might comprise: the implementation within the classroom of the description of the mathematical descriptors used; the visit of students to the centers of research, and the particular implementation of some parts of the applications by the students themselves. Finally, the scaling of this project (Wingkvist, A.C. (2009)) should be a matter of further study as well.

7. ACKNOWLEDGMENTS

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Toward Efficient Learner Supports under the Mobile Learning Environments

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Abstract
In this paper, we focus on supporting learners under mobile learning environments (ML), however it is considered very difficult issue because of the nature of ML. We show here that undisclosed macroscopic patterns or regularities in global level can emerge from the collective behaviors by learners in a learning group. We expect that such the patterns or regularities might be able to be employed as the useful information to support learners efficiently.

Keywords
Context, Time- Place-Oriented, Learner Support, Global Pattern

1. INTRODUCTION
As e-learning (EL) becomes very popular method for learning and teaching, the field of its application is expanding. Especially, m-learning (ML) is one of the hot research areas as the development of mobile equipments.

ML is defined as an EL that preformed by using mobile devices. One of the advantages of EL is its ubiquity, i.e., a learner has opportunities to start learning any time at any place. This advantage is enhanced by using mobile devices. In this area, researches and developments are progressing actively, as the expansion of functions in new devices as well as the popularization of these devices.

Due to the nature of ML it is very important to be paid attentions to the learning context, i.e., the time- and place-oriented learning (Sharples, et al. (2005)). Because, if a mobile learner moves from one place to another, the learner loses the chance of learning, and the opportunity for knowledge acquirement may be missed forever. Thus, it is very difficult issue to support mobile learner efficiently. Therefore, in this paper, we focus on the learners support under ML, through considering what information can be obtained for learners support under such environments.

2. PROBLEMS AND PERSPECTIVES
Even under ML environments, it is better for efficient learning that a learner can ask help for any supporting staff (e.g., e-mentors, hereafter referred to as EM, in Ishikawa, et al. (2009), etc.) during learning process. However, it is very difficult because ML environment is dynamic, i.e., there is any longer clear “learning course” and the supporting staff may be no more a certain person. Rather, in such environment, it is ideal that there is at least one person, but not the fixed person, who supports other persons’ learning at each time, even though, in the team for solving problems, every person changes his/her own positions or roles time after time in improvisational way. It is one of the main issues of learner support how to produce and work well such a team in dynamic and self-organizing (SO) way.

Unfortunately, this issue is not easy to solve. However, it can be helpful the reports in some research fields (Johnson (2002)) that complex structures in higher level emerge from simple actions of each agent which is limited to have local information (Camazine, et al. (2003)). Therefore, our problem has the same characteristics as emergence of swarm intelligence (Bonabeau, et al. (1991)) from the aspect of how to organize and manage a problem solving team and how to create and transmit knowledge dynamically and in a distributed way.

Furthermore, it must be reconsidered that EMs, in general, support a learner with various information for the needs of executing their profession. The information which an EM can access varies in every EL course. However, such information can include learning histories, results of test, learners’ personalities data that are obtained by psychological examinations or questionnaires on the course, etc. Under ML environments, it can become problematic to disclose to public such information, even though it is anonymous. On the other hand, there are some hopeful instances, in the area other than education or learning unfortunately, that information disclosure leaded to advantages or successes in Internet world (e.g., Tapscott (2006)). The Advantages of openness may change learners’ consciousness in the future.

It is also promising that, especially in the research field of complex systems, the group of people may show some specific macroscopic patterns in global level, even though each individual act in unexpected way (Buchanan (2007)). Therefore, it can be possible to manage and support a learner by information with less individuality. We show, in the next section, the possibility of learners support automatically and with less individual information.

3. RESULT AND DISCUSSION - ongoing
We show, in this section, an instance that a learner group in total, not each learner individuals, may show a macroscopic pattern or regularity in global level, through the analysis of the data which are obtained in the EL, not a ML unfortunately, course we provided. We expect to support learners efficiently by the information of the regularities or patterns.

This course is composed by 38 viewing materials (movies) whose viewing times are about 15 minutes in average. We opened such courses four times from September 2009 through March 2010 and there were 80 participants in total.

In all four courses, participants pushed the play (viewing start) button 3,878 times in total. There were 537 times out of 3,878 that participants pushed the button after more than the average viewing time (about 15 minutes) when the participant had pushed the button last time (hereafter, we refer to this time lag between sequential two button pushes as the time-diff). We plotted the time-diff values in Fig. 1.

The Y-axis of Fig. 1 shows time-diff values. The X-axis shows the ranking of each time-diff values in all observed values, in descending way, plotted in log scale. Such figures are drawn frequently to show, so-called, log-tail phenomena, although log-log plot are in common.

In Fig. 1, the plots are almost in linear. This may show that exponential values of time-diff, not time-diff values themselves, are under a power-law distribution. Here, we examined our data through scripts (plfit Ver. 1.0.10, plpva Ver. 1.0.7) programmed by Clauset et al. (http://tuvalu.santafe.edu/~aaronc/powerlaws/). The result is as follows;

x_{min} = 53.3932
p = 0.2480 > 0.1
gof = 0.0594.

Because n = 533, our data show highly fit with a power-law distribution.

On the other hand, Clauset, et al (2009) reported that a linearity of plots does not always mean the power-law distribution and goodness-of-fit should be examined comparing with alternative distributions. Thus, we examined our data by using Shalizi's scripts. The result is that the hypothesis of power-law distribution shows higher log-likelihood ratio (p = 1 for one-sided Vuong test) than that of log-normal distribution. Unfortunately, about all other distributions provided by them, N/A errors occurred and we could not compare yet. However, this result implies our data are under a power-law distribution.

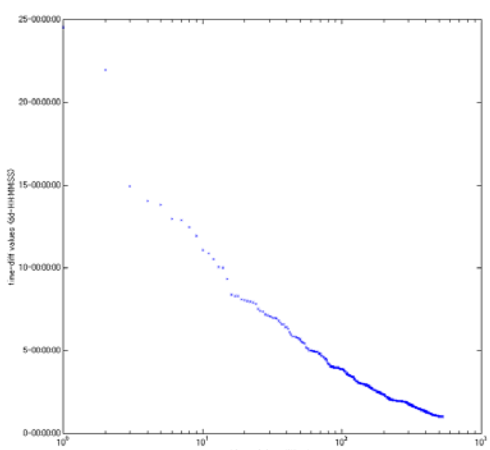

Figure 1: Time-Diff Values and Its Rankings

Therefore, there can be some undisclosed macroscopic patterns or regularities of global level in a learners' group. This information can be helpful for supporting learners. For example, the result may show what a specific behavior by a specific learners should be recognized in relation with the macroscopic pattern in global level. This information may indicate, e.g., regularity or irregularity of the specific behavior. Thus, it may be able to predict the future behavior of the specific learner. Moreover, it is advantageous that this information can be collected automatically and implicitly, that may lead to the possibility of an automatic learners' support, and that may be less personal and be allowed to be opened to the public.

We will continue to examine the same regularity in the data obtained in other EL or ML courses. We also consider the relationship between our result and SO phenomena because it is reported that SO process shows power-law distribution.

4. CONCLUSION

In this paper, through the analysis of the data obtained in our EL course, we show that a learner group may show macroscopic pattern or regularity in global that might be able to be employed as the information to support learners. This approach is possibly effective for establishing the method to support learners in ML environments.

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MOBILE EDUCATION: mobilQuiz, mobilGrade

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Abstract
With the help of information technology and multi-media teaching and learning for the digital production and use are becoming more common in recent times. Educational models used in the information technology systems began to be integrated. The goal of this study is; to develop web based (7/24) mobile learning platform. Enhance teaching and learning in education for electronic engineering students, to enable them to use media, to make mobile quiz system, to announce examination results on the mobile platform, to move social networking into mobile environment, and try to improve communication and researching students' learning experiences in m-learning. .

Keywords
mobile Quiz, m-learning, e-Learning, Distance Education, education.

1. INTRODUCTION
The last decade, the development and deployment of mobile technology to support learning research we have seen a rapid growth. Mobile devices are becoming more sophisticated. These devices can be used to access information from anywhere and at anytime. The device consists of an input mechanism, processing capability, a storage medium, and a display mechanism. The growth in wireless Networks / technologies are revolutionizing education, transforming the traditional ways of learning and teaching into 'anytime, anyplace' education. Mobile phones indispensable part of daily life has become. that wireless technologies are emerging as a portable solution that enables learners to engage in collaborative and interactive learning activities.[2] Mobile learning is a rather new term which received ongoing attention during the new millennium when mobile technology started its strong impact on society.

2. MOBILE LEARNING
The term M-Learning or Mobile Learning refers to the use of handheld devices such as PDAs, mobile phones, laptops and any other handheld wi-fi information technology mobile device that many be use in teaching and learning. Mobile learning can perhaps be defined as 'any educational provision where the sole or dominant technologies are handheld or palmtop devices'. The main advantage of Learning is that it is for "anyone, anywhere and anytime". MLearning makes education more accessible in that it enables learners to pursue their studies according to their own schedule. The portability of mobile technology means that mLearning is not bound by fixed class times; mLearning enables learning at all times and in all places, during breaks, before or after shifts, at home, or on the go. Especially the younger generation of mobile phones is seen as a part of life. Young people use mobile phones, SMS and other mobile services undoubtedly and without prejudice. Efficient use of these devices in order to create sites for mobile training began. Te speed of data transmission of 2.5G mobile phone is only at the rate of 30 kbps, it is too low compared with 3G at the rate of 384kbps, so 3G mobile phone is very suitable for being e-learning platform. The aim of the project was to develop web based (7/24) service using mobile technologies, to enhance teaching and learning in education.

3. METHODS, RESULT AND DISCUSSION
M-learning in this project to introduce students was our primary target. There was a very different feature of the device. Developed application has to supports many different media. Users would have to meet at a common platform. Therefore, we have designed a web-based mobile education pages. We have prepared three different format lecture videos. Video formats are 3gp (java based phones), mp4 and wmv. (smart devices/phones) (Table 1)

Table 1 : Video Formats

Video	3gp	Mp4	wmv
Format	MPEG-4	MPEG-4	Windows Media
Format profile	3GPP Media Release 4	Base Media	
Codec ID	3gp4	isom	
File size	5.08 MB	27.9 MB	33.6 MB
Duration	32mn 2s	32mn 2s	39mn 35s
Overall bit rate	22.2 Kbps	122 Kbps	119 Kbps

Social networking sites have provided. (Integration with Twitter) Mobile systems have electronic multiple choice pool system. The biggest advantage of this technology is that it can be used anywhere, anytime and adopt their mobile learning systems with the aim of improving communication and enriching students' learning experiences in their open and distance learning. Using information and communications technology in education has changed the learning process from the perspective of student, teacher, activity, and evaluation. Applications of mobile phone have become diversified and derive many services in many fields.

Our developed system is built using Microsoft technologies including, C # ASP.Net, Windows Server, Internet Information Server (IIS) and SQL 2005 Server. The eXtensible Markup Language (XML) web services is used to develop applications. XML allows users to define their own elements. All data exchanged via these services were provided. Its primary purpose is to facilitate the sharing of structured data across different information systems, particularly via the Internet. It provides basic syntax conventions that are familiar to a large number of users, especially in the Web environment. XML provides services to independent service platform, will be possible with the help of it.

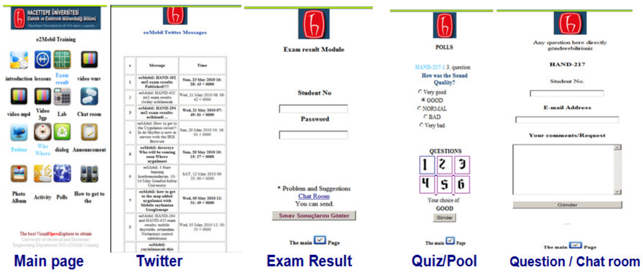

Figure 1: M-Learning Web Pages

(http://uzi.trt.net.tr/e2mobile)

Information about the project after the initial curiosity of the students use the system was 16.4%. Later, this proportion increased rapidly with additional features. Used to encode video and audio at an acceptable level of 70% was noted. But connection fees are high and some wi-fi connection problems, because of those students didn't download video by phones. Although 100% of students mobile phones, no one has access to the site from a mobile. Most Students downloaded and watched the video and audio from the Internet; they said they liked the quality. Assuming 3g/data cheaper prices, but when 70% of the sector is also interested in these issues has been identified.

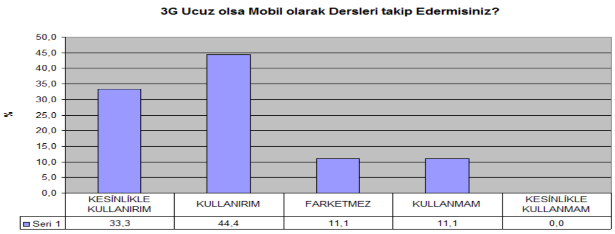

Figure 2: Would you follow the lessons if 3g is cheaper?

Videos of courses, surveys, test results and other activities for students of the announcement has created great excitement and Increased motivation. 54 students in the class to 87 people although it was announced, 109 students were using the system. Some students are not enrolled in the course of using the system have been found. Over a period of three weeks just learning grades page, 109 students entered 421 times. Take the time to learn the grades were avoided. Students did not have to go to campus and they did not spend time and money. Students at this time were devoted more time to study for final exam. In certain periods of active multiple-choice questionnaire was developed. Surveys and quizzes on the day and time we want to be prepared to become. Courses can be created for each different quiz. In the next half-term of the order of the questions asked and answers that were obtained by mixing specific person, there are automated appraisal system that is planned to return to quiz system. In this way, more students the opportunity to quiz will arise. As a result, students are targeted continuously be prepared.

4. CONCLUSION

In our study, advancements in technologies have changed the process of learning. Integrating mobile devices and mobile application development into courses raises the level of excitement and satisfaction and provides a motivation for students. The use of mobile Technologies; such as mobile phones, PDA, Laptop, Netbook etc, also incorporates a new concept for teaching and learning in this environment. We have obtained excellent results. Mobile learning applications for students were not far away. The students also were keen to use all sources of m-learning approaches. With the success of mobile surveys and feasibility were detected quickly. Asked questions and answers as well as the 160 character SMS without limitation applications successfully tested with many options. The system from any internet connection that can be used with the device had been targeted. Due to the high cost of internet access 3G and mobile devices with the exception of students with devices that use the system. But, mobile networks are becoming commonplace and the quality and capability is increasing while costs continue to drop.

We are working on a system for dynamic and personalized quiz and auto grading system would also continue to work. Applications for mobile users to increase their interest in learning at work are ongoing. We will be releasing and sharing with the community once it is ready.

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Some results of the MOTILL project

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Abstract
In this poster, we present some results of the MOTILL project. MOTILL, which stands for "Mobile Technologies in Lifelong Learning: best practices", is a one year project. It was funded with support from the European Commission within the National Lifelong Learning Strategies (NLLS). The project ended in March 2010 has focused on the use of mobile technologies as a key factor in developing flexible LLL frameworks for education. Firstly we introduce the project, aims and outcomes, then we provide some results available online that should be useful to researches and policy makers involved in Lifelong Learning program.

Keywords
Lifelong learning, mobile learning, policy makers.

1. INTRODUCTION
Many researches have been considered mobile learning as the future of learning or as an integral part of any other form of educational process in the future. The widespread diffusion of mobile technologies in all EU countries offers an opportunity to develop policies aimed at participation and social inclusion, considering that the use of mobile devices transcends age, social status, economic level, gender and ethnic origins. Moreover, in literature there is considerable evidence to suggest the positive impact of mobile technologies upon lifelong learning. Mobile technologies can promote social inclusion through increased participation in learning, learner choice, and flexible or personalised learning programmes, which can take place anywhere and at anytime. Mobile technologies have been shown to be particularly effective at reaching learners who are often overlooked by traditional forms of technology-enhanced learning, and so can contribute to meeting lifelong learning targets. However, in order to maximize the benefits of mobile technologies for increasing and widening participation, adult learners should be given adequate support when developing their use of mobile technologies.

The main aim of the project, which we present in this poster, is to sustain the use of mobile technologies for empowering lifelong learning national policies. For this to happen one of the most important aspects of the MOTILL project is the involvement of policy makers to promote local and national targets for lifelong learning in line with European benchmarks and strategic objectives. In fact, policy makers play a crucial role in this field because of their capacity to promote the benefits of mobile lifelong learning by making the best use of the efficiency of mobile working, learning and teaching in their own institutions.

The partnership of the project was composed by academic and research centers coming from four European countries (Italy, United Kingdom, Ireland, and Hungary).

The MOTILL project also provides to the policy makers evidence, and good practices on the use of the mobile technologies to improve the LLL so that for example to help them in: setting out strategic priorities that contribute to meeting existing and future targets for adult learning, vocational training, and higher education; to support the development of next-generation mobile networks and the reform of European telecommunications.

As illustrated in figure 1, the MOTILL project brought the identified good practices and methodologies to the attention of policy makers. To achieve this goal, the partnership introduced the policy makers to the state of the art on how mobile technologies can best support lifelong learning (the SARD: a Scientific Annotated Review Database offering reviews papers concerning the use of mobile technologies in LLL), as well as the good practices in this field resulting from the main activities carried out in the partner's countries (the BPC: a Best Practices Collection assembling the most relevant mobile learning projects carried out in the partners' countries). Finally, partners signed national agreements as declaration of intent with Research Institutes, Universities and Policy Makers to promote new national initiatives in which mobile technologies will play a crucial role in lifelong learning strategies.

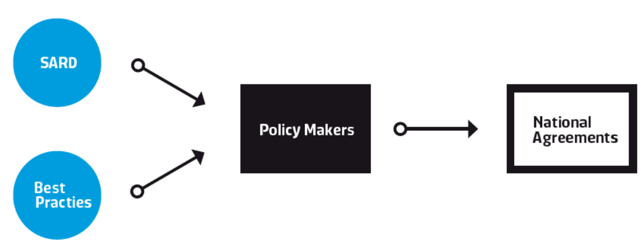

Figure 1: Figure Caption here

2. THE MOTILL OUTCOMES
In next sections we shortly present the SARD, the BPC and the methodological framework we have designed, then we provide some results.

2.1 Scientific Annotated Review Database

The SARD is a Scientific Annotated Review Database that provides a comprehensive set of references to the major research initiatives concerning the use of mobile technologies in Lifelong Learning (LLL) supported by integrative and critical commentary. This database is accessible online to the community of scholars, teachers, and researchers. Its content is also relevant to policy-makers, as the reviews include specific comments on the implications of research for policy. In order to design the SARD, a rigorous approach was adopted to collect, tag, and review the selected research initiatives. The project team first identified appropriate descriptive 'common tags' and key concepts in mLearning and Lifelong Learning and grouped these into categories; then, the tags have been used to classify the research initiatives.

2.2 Evaluation Grid

The Evaluation Grid, conceived as a tool that would enable MOTILL project partners to work in a consistent manner to identify 'best practices' in the use of mobile technologies for lifelong learning, whilst taking national and local contexts into consideration. The Evaluation Grid has been used in interviews with those involved in the best practice projects, to get more information about each instance of best practice.

2.3 Best Practices Collection

The Best Practices Collection (BPC) collects the most relevant mLearning projects identified following the guidelines defined by means of the Evaluation Grid. In order to promote and improve the visibility of good practices, the BPC is also accessible online via the MOTILL Web Portal (www.motill.eu).

2.4 Some results

Considering the short-term objectives (to involve policy makers who should sustain the strategic plans and learning activities based on the results of the project) and long- term objectives (promote an increase in the number of people involved in training programs) of the project the following strategies have been applied to reach the target groups:

- participation in national and international meetings devoted to mobile learning and technology enhanced learning;
- organization of meetings; interviews with educational agents;
- agreements with policy makers and education agencies;
- diffusion of information on the web and publications

In table 1 we summarize some results and actions carried out within the MOTILL project.

Table 1. MOTILL outcomes and results

SARD	Papers reviewed	51 peer review scientific papers
	Accesses	1000 during the project, 4000 accesses is expected in the next year
BPC	Projects included in the collection	11 projects identified in the partner countries.
	Accesses	Same of the SARD
National Agreements	Agreement signed	27 signed in Italy, the UK, Ireland, Hungary and the Netherlands

During the project, other educational institutions besides the members of the consortium were involved. Particularly, in the partners' countries, more than 60 people from 47 Research Institutes, Universities and Policy Makers were involved in the MOTILL National Meetings. Moreover, the project results were disseminated to about 2000 Researches, Teachers, Decision Makers throughout 18 National and International conferences where the project was introduced.

3. CONCLUSION

Several studies have evaluated mobile and wireless technologies as being particularly suited to the implementation of the LLL paradigm; in addition, the scientific community has highlighted that mobile learning could be a suitable methodology to support LLL. Despite this, national policies have not yet taken any significant step to integrate LLL and mobile technologies. The MOTILL project brought the identified good practices and methodologies to the attention of policy makers in order to promote the benefits of mobile lifelong learning.

In line with the initial objectives of the project, several national agreements (Declaration of intent for best practices adoption) were signed with Italian, British, Irish and Hungarian policy makers, the national agencies in the learning and training sector, research institutes, universities, local agencies, schools, entrepreneurial associations and vocational institutions. The large number of agreements signed (in total 27) with these prestigious policy makers proves that the MOTILL results have been greatly appreciated.

4. ACKNOWLEDGMENTS

A brief acknowledgement section may be included in the camera-ready paper.

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MICE: Mobility In Case of Emergency

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Abstract

Many people lose their lives because of inefficient or lack of effective communication in case of emergencies, thus creating panic and chaos which generally result in confusion and disorganisation. This project aims at targeting the problem of ineffective communication in case of emergencies during open air mass events by exploiting internet, mapping, GPS and mobile application technologies. MICE (Mobility In Case of Emergency) is a mass notification and monitoring system which will observe and provide civilians with useful information about the event area depending on their location when there is no imminent threat as well as direct civilians to safety during emergencies, thus ensuring the safety general public safety.

Keywords

Crowd management, Location Based notification, wireless.

1. INTRODUCTION

Crowds and crowd management are always an issue, especially in cases of danger and emergencies. In events which attract the general public such as music concerts and mass meetings, providing effective information in cases of emergency is a major concern. Under such conditions, providing useful location information to the travelling public is rapidly needed both to maintain the safety of travelers in the disaster area as well as direct travelers travelling towards that area to areas which area safe and free of danger (U.S. Department of Transportation, 2007). "When an area is threatened and evacuation is called for, information needs to be disseminated that prompts people to travel out of the area as soon as possible and along safe routes" (U.S. Department of Transportation, 2007). Due to such situations, ineffective communication can definitely increase the probability of the general public being risk.

The primary aim of this project is that of targeting the problem of ineffective communication in situations of emergency during events which involve crowds and the general public by using modern and vastly used technologies currently available in the market. In fact, Mobility In Case of Emergency (MICE) is a mass notification monitoring system which promotes effective communication by using mobile phones to instruct civilians during emergencies. Besides being constantly monitored and tracked during events, civilians are provided with useful information which will help them reach an area that ensures their safety and well being. Such information includes closest (and safest) emergency checkpoints, mainly police stands, ambulance stands, evacuation points and assembly areas.

In addition to instructing civilians during emergencies, MICE is also an informative system that an information mechanism which might help the public in case an emergency occurs. This information is intended the notify civilians about assembly areas, evacuation points, ambulance sites etc. in their vicinity so as to prepare them for unforeseen circumstances, thus making sure that they know what to do and where to go as a first reaction in response to an emergency situation.

2. AIMS AND OBJECTIVE

In order to focus and prioritize the effort in working on the project as well as provide a method for evaluating the work carried out, a list of aims and objectives was formulated. The aim of this project is that of understanding, analyzing, designing and implementing a system that:

Allows the retrieval of a particular site and the customization and planning of that site to cater for emergency situations;

Provides a mechanism of raising an alert in case an emergency occurs;

Provides a way of monitoring the public attending a particular event hosted at a particular site;

Provides the public with area information (e.g. the closest assembly area) to formerly prepare and notify the public in case an emergency occurs;

Guides civilians intelligently to safety in case of an emergency;

Supplies information about which civilians might be mostly at risk.

3. DESIGN

After carefully observing and designing the system from various view points (e.g. system data flow, uses cases, etc.) the system was designed to be composed of five basic entities (Figure 1):

- *A database*, which will be used on and handled by the server side to store the required information for system operation;
- *A server*, which will handle the database and expose a number of services over the internet to

the remaining entities, in particular the Location Based Service for mobile clients.

- *An event editor application*, which will be used by administrators to create and organize events;
- *An observation post application*, which will be used in parallel by a number of administrators to observe civilians and raise and resolve emergency during the event;
- *A mobile client application*, to be used by clients who are willing to retrieve location information during the event.

4. IMPLEMENTATION

Basing on the observations and decisions made during the design phase of development, the MICE System was implemented as a package of 4 software entities, namely:

- *The MICE Server*, which is responsible for and handles the MICE Database, and exposes a number of web services to be used by the other applications;
- *The MICE Event Editor* application;
- *The MICE Event Observer* application;
- *The MICE Mobile Client* application;

Figure 2

5. RESULTS

Testing is one of the most important parts in the development of a software system. In fact, testing allows the correct validation and verification of what has been produced, making sure that the proposed system adheres to all of the necessary requirements and objects set in earlier stages of development.

6. CONCLUSION

Regardless of the various challenges and problems faced, the completion of this dissertation has lead to the development of a software system which successfully fulfils all the goals and objectives it set out the target. As a matter of fact, the Mobility In Case of Emergency (MICE) System is a mass notification and monitoring emergency system which, by exploiting modern technologies, aids in the creation, planning, organization and observation of mass events and most importantly, ensures the correct and accurate provision of timely location and emergency information to connected clients attending these events.

All facts together, this dissertation presented a new and innovative system in the field of safety and emergency. By exploiting modern and currently used technologies, the MICE System will reliability and efficiently guide clients while they attend mass events, providing them with useful information about the event area depending on their location and most importantly, help them restore and/or maintain their safety and well-being in cases of emergency.

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Locating Personnel on Site

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Abstract

Real Time Location Systems are becoming an innovative concept in today's industry. Organizations require ways and means to identify and control the location of their personnel for various reasons, such as, ensuring that enough staff are addressing a particular current task that needs to be carried out and that demands the attention of a number of floor personnel. Such a system will not be limited to just keeping tabs on personnel, but can be used to quickly locate personnel in an emergency environment. This project will be aimed at such organizations or environments, to help the top management locate personnel, whatever the reason might be. Using Radio Frequency Wireless Technology, the system will help the user locate personnel, by offering various features, such as, a visual and graphical presentation of the workplace environment, including moving Tags and stationary Tag-Readers.

Keywords

Emergency personnel, localization, wireless.

1. INTRODUCTION

The main focus of this thesis is the localization of personnel in a closed environment to assist in human resource control and leveling. In massive working environments, managers or human resource supervisors require ways and means to identify and control the location of their employees. Similarly, such a system would assist managers keep control of their personnel, ensuring that such expensive resources are employed efficiently and effectively. Such a system, is not limited to just keeping tabs on the employees, however it can be also used to locate an employee who is needed by someone else.

In order for this system to work, the building of the hardware devices, as well as a software solution needed to be implemented. Once the system is implemented and an environment is chosen and set up, the user of this system will be able to follow the employees, or whoever is being tracked, visually on screen. The components that make up the system are: Tag, Tag-Reader and Reader hardware components and Content Management System and Location Tracking software applications.

2. AIMS AND OBJECTIVES

The main aim for this thesis study is to have a successful interaction between the different components of the system, and successfully represent the data visually for the user to be able to successfully locate any employee who is registered with the system.

This will not be an easy task, since we have to come up with a solution which does not depend only on the software, but on a lot of components and the integration between said components. As this system is going to be implemented on a real model, rather than a simulator, many more factors will come into play and determine the degree of success of this project.

If the main aim is achieved, the system could be used in any environment and any work place. This in fact was another aim, to implement the system as dynamically as possible, so if a change of scenario is needed, this could be done from within the application without the need of changing any of the code in the two Software Applications.

3. DESIGN

The system is made up of various components. Each and every one of the components is extremely important for the system to function properly.

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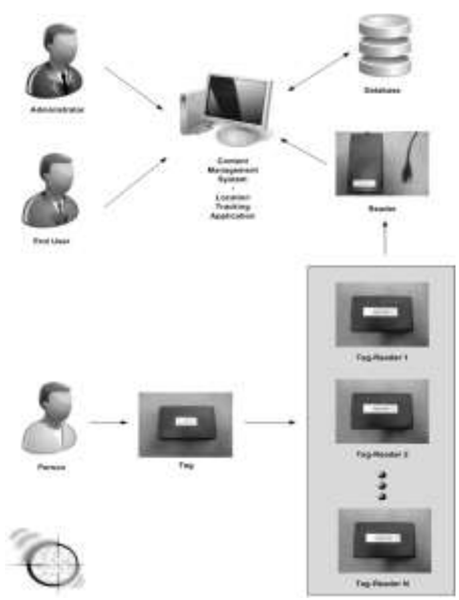

Figure 1: System Architecture

In Figure 1 we can see the different components that make up the system, that is, the three hardware components, the two software applications, the database and the different people driving the application.

4.1 Database Design

A database was used by the Content Management System and the Location Tracking Application, but not by the

Hardware components. Appropriate tables were set up dynamically in the created database and will be used to save or retrieve data from the two software applications.

4.2 Hardware Design

The three hardware components designed for this system to work are:

Tag: The Tag component needed to have a portable power source due to its purpose of being carried around by people that needed to be tracked.

Tag-Reader: The purpose of the Tag-Reader component is to pick up the pings that the various tags are leaving, thus acting as a Reader, and send the data received as well as other relevant data to the Reader component, thus acting as a Tag.

Reader: The Reader component does not require any other power source except, a USB cable to be connected to the computer. This component will be the only one connected to the computer. The purpose of the Reader component is to receive data from the Tag-Readers and print it on the Serial Port.

4.3 Content Management System Design

The Content Management System, also known as CMS, can be described as the Back-End system application. Only the administrator will have access to this application, or anyone that is registered with the system, that is has the necessary credentials to be able to access the application. The CMS was designed with a specific purpose in mind: to prepare the environment in which the Location Tracking Application is to be used.

4.4 Location Tracking Application Design

The Location Tracking Application can be described as the Front-End application of the system. The scope of the Location Tracking Application, also known as LTA, is to give a visual representation of how the tracking system is working.

5. IMPLEMENTATION

This entire project was created using two well known languages:

Python: RF Engines require SNAPpy scripts in order to work. Portal development environment. Using this Python editor we are able to invoke routines contained within Portal scripts.

Visual C#: The IDE used to implement the two software applications was another one of Microsoft tools, that is, Visual Studio 2008.

5.1 Hardware Scripts Implementation

In order to implement the hardware components, we developed three different scripts using Python. These three scripts were uploaded to the Tag, Tag-Reader and Reader components respectively.

5.2 CMS Implementation

The Content Management System was implemented in C# using the Visual Studio 2008 Integrated Development Environment. The data was continuously read from the Reader component connected to the computer using the BackgroundWorker and SerialPort classes.

5.3 Location Tracking Application Implementation

The Location Tracking Application was implemented in C# using the Visual Studio 2008 Integrated Development Environment. The data was continuously read from the Reader component connected to the computer using the BackgroundWorker and SerialPort classes.

6. RESULTS

Extensive testing and evaluation was done on the different components of the system as well as on the system as a whole. After using two types of testing, being Unit Testing and System Testing, we can say that the system meets the requirements, aims and objectives that were defined previously.

7. CONCLUSION

Radio Frequency wireless technology can be used to facilitate personnel tracking in different environments. This poster is a brief narration of how it was achieved.

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Mobile Augmented Reality in an Arts Museum

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Abstract

Advancements in information communication technology have enabled the interaction between human beings and the material world in various ways. This dissertation aims at presenting augmented reality as an ideal tool for enhancing students' experience in an arts museum. This is achieved through the development of a mobile application that allows visitors to view virtual information and computer generated graphics of works of arts in greater details. By implementing the application on the open source Symbian platform, the 'Museum AR' system can be run on a wide range of mobile devices. The system is put to test at an evaluation session held at a local arts museum. The positive feedback gathered from museum visitors continue to prove the usability of mobile augmented reality, especially in reference to the benefits offered to arts museums by implementing this technology.

Keywords

Augmented reality, cultural heritage.

1. INTRODUCTION

Artists convey their emotions and thoughts through arts. Lines, textures, sounds and colour are just some of the mediums used to put their message across. Although interpretation of an artwork or artefacts can vary from a person's perspective to another, the user should be allowed a thorough examination of the work of art to aid him/her to comprehend better the artist's perception. Unfortunately, because of some constraints, certain artefacts, such as sculptures, are very often not fully appreciated, due to lack of possible interactivity with these objet d'art as a consequence of their nature and fragility.

Museum curators do their utmost to create an enjoyable experience for students while increasing their understanding about the works on display. Arts museums strive to deliver their collections in the best possible format to be appreciated by as many students as possible. For this purpose, students are asked to refrain from touching the artefacts. This may prevent the students from realising certain details which the artist may have placed in his/her work. Moreover, students may not be able to value certain features found at the back of the artefacts due to their inability to analyse the object from multiple angles. Another issue faced by museums is that very frequently they are limited by space and resources to exhibit their collections. Children often lack attention in museums and do not realise the meaning of certain artefacts. Thus, innovative approaches must be employed to bring playfulness into learning about cultural heritage. Use of the latest technologies can be used to overcome some, if not all, of these drawbacks.

Cultural heritage is one of the domains in which augmented reality (AR) can be exploited. Augmented reality refers to the imposition of virtual entities within a real world perspective. The user's viewpoint is augmented with computer generated images and 3D models positioned next to real world entities. This gives him/her the impression that they exist in the same real world environment. An augmented reality device consisting of a small video camera and a display screen which will capture the user's perspective and render virtual images on top of the video stream. Markers are used to track the position, angle and distance away from the user, where the 3D visualizations must be laid on screen.

2. AIMS AND OBJECTIVES

The focus of the work presented in this thesis will be on the applicability of an augmented reality application in an arts museum. Qualitative and quantitative evaluation will be conducted to evaluate the applicability of a simple augmented reality mobile based application, in order to identify the extent of the benefits that augmented reality can offer to museums and how it can be used as a learning tool to educate students on cultural heritage.

This project strives to reach the following aims:

- present augmented reality as an ideal tool for enhancing students' experience in a museum;
- to identify the mobile device as an effective medium for augmented reality;
- to investigate how augmented reality can enhance the user interface of mobile phone; and
- to implement a mobile augmented reality application.

The following objectives are laid to aid in reaching the aims of this project:

- to investigate the possibilities and weaknesses of mobile augmented reality in a museum environment
- to develop an augmented reality system using existing hardware components and tools
- to provide students the ability to interact with artefacts by using their mobile phones in an arts museum.
- to evaluate the system in a museum environment to demonstrate the potential of augmented reality

A model of the flow of data at the different stages within the application can be seen in Figure 1.

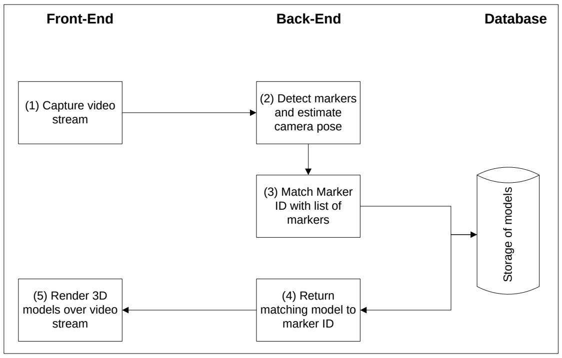

Figure 1: A modular view of the 'Museum AR' application

To illustrate the functionality of each component in Figure 1, the 'Museum AR' application is followed through a typical sequence of events.

a) Once the application 'MuseumAR' is started on the mobile phone, the camera is initialized to start capturing video.
b) In order to deliver the 3D content, fiducial markers need to be detected on the mobile screen during the live-streaming of video. Each frame of the video stream is converted into a binary image in order to make it easier to identify the black and white portions of the fiducial marker. The image is then scanned to check if it contains any markers. Fiducial detection occurs once all corners of the fiducial markers are identified within the image. The pattern on the marker is then checked and if it is valid, camera pose estimation is computed to calculate the distance of the mobile phone to the corners of the fiducial marker.
c) The marker's ID is identified by the number of bits on the pattern. This marker's ID will then be matched with a list of IDs stored in the application, where each ID refers to a different 3D model. Once a matching ID is found, the application searches for the relevant virtual model's file.
d) As the contents of the matching model are retrieved, the rendering of 3D content on the handheld device can take place. The introduction of a dedicated graphics processing unit on mobile phones makes it possible for 3D images to be rendered directly on the mobile phone. OpenGL ES offers an open source API that allows the rendering of the virtual models on the mobile device.
e) In the end, the generated computer animation is superimposed over the video stream to provide an augmented view of the 3D model onto the real world domain.

3. TESTING AND EVALUATION

In order to assess how potential users will find the usability of the Museum AR system, the application was tested in a real context at the Museum of Fine Arts, in Valletta, Malta. A quantitative and qualitative result was obtained by giving the museum visitors an opportunity to use the application and report their observation by filling a prepared questionnaire.

4. CONCLUSION

This poster investigated the applicability of augmented reality in arts museums. By identifying the mobile phone as an effective medium for augmented reality, a mobile application was implemented with the aim of enhancing the students' experience in museums. The 'Museum AR' system provided a bridge between the real and virtual worlds by allowing the museum visitor to view virtual information in his surrounding through the use of his mobile phone. This application increased the usability and usefulness of the mobile phones as the integrated camera was turned into a sensor to track fiducial markers. The positive results obtained from the evaluation session continued to prove the huge benefits of augmented reality, in particular to arts museum, and encourages further development of the 'Museum AR' system as it establishes itself as a great learning tool to educate students about cultural heritage.

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Still and fruity: a blended MALL tapestry-cum-dialogue.

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Abstract

This poster provides a pedagogical perspective on the outcomes of my language students' involvement in a recent MALL project using Google Android phones. It seeks to explore reasons for the success, and lack of success, suggesting reasons for both.

Keywords

MALL, learner autonomy, ownership, informal/blended learning, teacher/learner roles.

1. INTRODUCTION

A recent UK project developed a mobile phone-based tool to allow language students outside the classroom to capture and annotate and share items of interest.[1] One aim of the project was to discover whether the tool was suited to independent use, integration into teacher-led activities, or both. My involvement was as both a teacher and demonstrator. It was my aim to take an ostensibly informal learning tool, and investigate to what extent it could or should also function as an effective integrated teaching and learning tool in and out of class for language learners.

1.1 Learner Profile and Needs

My learners were all aged 18-23, and were all studying at Sussex University in the UK at International Study Centre, which is a provider of pre-university Foundation and Diploma courses. The learner group consisted of five students, four of whom were from mainland China, and one from Nigeria. The Chinese students were of an intermediate level (approximately IELTS 5-6), while the Nigerian was a more advanced user (IELTS 7-8), the level for which this mobile application was first conceived. They were in a small, discrete ELPP (English Language Preparation) group because for different reasons they required remedial attention for EAP (English for Academic Purposes) in order to gain access to their next course. I chose this group to be the ones who should receive a state-of-the-art mobile phone pre-loaded with the application since they each needed extra motivation in order to improve their grades, and I anticipated that this would a) be viewed as a VIP-type 'reward' b) help them gel as a (disparate) group, with a common purpose. Consequently, we also gave each of the three teachers teaching the group (myself included) the same phone and application to mirror the learner experience.

[1]CloudBank: a JISC Rapid Innovation Project.

2. LEARNER OR TEACHER-INITIATED ACTIVITIES?

The impetus behind the evaluation was to find out the extent to which learners at this level would be willing to take charge of their own learning. One aspect of this is the balance they would achieve between learner-initiated and externally-initiated learning (Sharples, 2009). Taking the concept of student control even further, we were interested in finding out how students would take to the notion that MALL can help learners 'co-construct knowledge' (Kukulska-Hulme and Shield 2008).

2.1 A blended hybrid approach

Our project was something of a hybrid in that it was initiated externally, but then encouraged, indeed *required* learner-initiated content to generate interest and activity. The premise behind Cloudbank is that learners in the 'front line' (Pemberton et al, 2009), encounter a word or phrase that interests them, and then *in situ* use the mobile phone to take a photo, add audio or just type in the word or phrase they encounter. This is then automatically uploaded to a server which 'banks' the information, thus making it available and visible to the other learners in the group. Essentially, it is a Constructivist bottom-up dictionary, in its "purest" state, starting from scratch, with no other words to refer to.

2.1.1 Mini case study: 'still and fruity'

One example of how it works is the entry for the word 'still' (see Fig.1). Here the context is fairly clear as the learner has supplied a photo of the label of a flavoured drink which clearly reads 'Still and fruity'. What is interesting to me as a teacher is that the learner is probably wondering:

a) 'What does still mean here? I know the meaning of still as in unchanging; *still for sale'*, and b) 'Is 'still and fruity' a useful phrase I need to learn?' Of course, as it happens, *still and fruity* is an invented collocation; a piece of fairly unremarkable marketing rather than a frequently-used, flexible and culturally-rich phrase which may be of use to the learner. Such a collocation would be difficult for a learner. I can confidently say that no one in the class would have been capable of 'unpacking' the cultural reference points and lexical chunks. I used this example in class to teach/clarify various meanings of *still*, and also highlight typical collocations: law and order; fish and chips; rock and roll etc. However, the impetus, or syllabus even, in many respects, is very much learner-centred/generated. As Kukulska-Hulme argues, it is M-Learning's 'affinity with movement between indoors and outdoors, across formal settings, [which allows] learners to lead at least some of the way' (2010: 164).

Figure 1: Screenshot of a learner's posting of the word 'still', which helps provide a fuller context: 'still and fruity'.

2.2 Learner and teacher roles and motivation

Most notable was certain learners' apparent reluctance to provide definitions for many of their own or others' postings. Hence, many words or phrases remained disembodied linguistic 'islands', often devoid of context, nuance or tags, the latter being the main organizing principle available to them. Subsequent discussion with the students revealed that while they were happy enough to upload words and phrases into their phones, they felt it was the teacher's job or role, and not theirs, to supply definitive or authoritative information.

2.2.1 'Ownership' of information: Teacher as 'authority' or 'facilitator'?

One posting simple read 'blackberry', and was accompanied by the tag 'cell phone' and showed a photo of a Blackberry phone. This was a reasonable, if somewhat limited entry. It is valid to do nothing more with such an entry. However, as a cultural and linguistic native, the teacher can take meaning to another level**.**

On this occasion the teacher did not add anything further. However, to use the full potential of the system, this would be a good opportunity to tag it with, say, 'crackberry', and link to a news article about Barrack Obama's self-confessed addiction to his Blackberry during his successful attempt to get elected. Here the teacher is an authority. However, she has the option of being facilitator instead, asking the learners to research and comment on the word 'crackberry' rather than supplying them with the 'answers'.

2.2.2 Ownership of devices and usability

As Traxler (2010) notes, students' mobile devices are very much an extension of their identity, and their familiarity with their device is paramount. Tellingly, my learners:

a) soon got frustrated with having to carry around a second phone and charger

b) did not wish to invest time and effort into getting to grips with a new interface (often inferior in usability terms to the ubiquitous iphone many of them already owned).

Revealingly, even the teachers, whose own phones were often inferior, described the same reluctance to carry two phones.

2.2.3 A socio-linguistic inventory

Almost incidental to the project's initial aims, it occurred to me that what we now have now, thanks to the tagging system, which reveals whether a learner or a teacher has uploaded data, is a fascinating socio-linguistic inventory or inter-cultural tapestry-cum-dialogue which documents what these learners and teachers each perceived to be notable linguistic events.

3. CONCLUSION

This trial with CloudBank demonstrates the validity, usefulness, and considerable potential of a blended dialogue between learner and teacher in MALL, but also raises questions about teacher and learner role, and perhaps most importantly that of the (lack of) ownership of a single device and its likely effect on diminishing use.

4. ACKNOWLEDGMENTS

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Open Mobile: institutional responses to mobile learner support

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Abstract

This poster will outline some of the steps that The Open University is taking in providing a range of learning services and materials to an increasingly mobile-aware student body. In particular, providing a mobile VLE or LMS through customised Moodle templates and modules will be illustrated, alongside more subject-specific content packages and applications. Further enhancements and interventions are listed, where the university is adopting strategic cross-institutional solutions to work with our mobile learners in addition to subject-specific trials and pilots.

Keywords

MobileVLE, apps, eBooks, eAssessment, strategy, mainstreaming

1. INTRODUCTION

For some time, The Open University in the UK (OU) has been involved in exploring uses of mobile devices' standard features or customised applications to aid in teaching and learning (Kukulska-Hulme & Traxler, 2005). For a distance-learning organisation, the challenges in use of mobiles are not the same as for face-to-face, not least through irregular contact time, familiarisation and in-person support - either with peers or with specialists. The primary aim for the OU is to enable students to make best use of most familiar (mobile) technologies, rather than dictating a particular solution. We also keep track of usage and platforms, and have tracked mobile device accesses to the main StudentHome portal since 2006 (Figure 1).

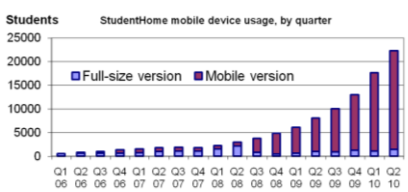

Figure 1: StudentHome mobile usage

Quarter upon quarter, mobile usage has been growing to about 22K individual accesses. Also once device detection was put in place in mid-2008, most users continued to be happy to take advantage of a stripped-down mobile-optimised version of the portal. The numbers are significant enough for the university to respond in a more strategic way, beyond smaller-scale trials and pilots. The remainder of the poster will illustrate a few examples of recent work.

2. RECENT WORK

2.1 Mobile VLE

To respond to the existing student usage of mobile technologies, a self-selecting group of 196 StudentHome mobile users were surveyed in Summer 2009 (Thomas, 2010) to gain insight into their use of devices and to set priority areas for development work. Specific questions were asked as to the kind of learning tasks or activities students would expect or prefer to undertake while mobile, taking account of pre-planned or unanticipated free time. Providing better access to updates and online activities as well as resources while mobile (and keeping parity with desktop access) was seen to be the most important factor.

As a result of the survey feedback, a roadmap (Figure 2) was put in place to deliver the following priority areas for development: Assessment; Messages; Tasks; Planner; Resources; Calendar; Search; Glossary; Objectives (Mobile Learner Support, 2010).

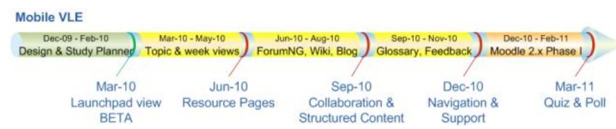

Figure 2: Mobile VLE Roadmap

The screenshots included in the poster show a few of the content and collaborative tools now made usable on mobile devices - as device-independent as possible, but mainly targetted at the largest 'mobile WebKit' browser class such as those found in iOS and Android, with similar success in use of Opera Mini on other mobile phones.

StudentHome mobile users will again be surveyed to gauge the effectiveness of these solutions, also to inform further development work in 2010/2011. While most work has now been completed for v1.9x of the OU customised version of Moodle and modules, the OU is also moving into a new development phase with Moodle v2.x and will be able to share more with the community during 2011.

2.2 Mobile apps

There are of course cases where more customised approaches are more favourable. In particular, being able to access content using rich media and interactivity requires native device development or use of a standard formats and helper applications, in addition to website functionality.

In order to achieve offline access and more flexible usage of multimedia-rich content, the OU has invested in creating a podcasting service. It is the same infrastructure that drives some of our public resources in iTunes U (Knowledge Media Institute, 2010) or YouTube. There is increasing evidence that more and more users are now 'sideloading' podcasted content to devices or downloading 'over-the-air' rather than the previous desktop consumption model.

Building on the capabilities of iOS and Android devices have allowed the OU to prototype a number of multimedia and interactive apps - which cater for subject-specific content in standard frameworks and effectively a number of linked learning objects (Mobile Innovations Group, 2010). At the same time, other developments have taken place to enhance eBook formats in line with Apple (ePub) and Kindle (mobi) updates, as well as a pipeline system to take structured content in XML and output alternative formats.

One particular prototype concerned taking the standard web-based output of our structured content course material and providing a version that can be electively downloaded to a student's device for use offline or when connectivity is intermittent. Unique features of this app were that the student can sign in to the app - which then handles authentication, permissions and then verify if content packages are available to download. The native feature of the app is in playing multimedia content and how interactions or gestures are mapped to actions. Screenshots will be included in the poster.

While UK HEIs may not yet be as prevalent as their US counterparts in the mobile app space, development of mobile apps - large and small - is firmly on our roadmap.

2.3 Mobile optimization, and alternates

A substantial part of internal work has gone in to better enabling our learning systems to support our students who are mobile, but there are also initiatives where mobile methods have crossed-over and supported other activities.

A recent example is the use of mobiles in eAssessment. Through partnership with Learnosity (Cooney, 2010), a mobile languages project was undertaken in 2009 to evaluate student response to engaging in different ways with some oral and aural exercises. Formative, self-paced activities were chosen from mostly pre-existing DVD-ROM based content. The adoption of the use of a phone-based system allowed for a more authentic experience modelling a more realistic conversational interaction.

This particular example explored the mobile dimension specifically, and as a consequence the number of ways that a student could interact grew to cover web-based, Voice Response via phone, Skype, mobile - both using a voice call and iOS app. Work is now underway to establish these methods within tutor assessed work and to explore different contexts with a mainstreaming aim in mind. The extension of this kind of activity so that mobile is just one facet of eAssessment has resulted in greater acceptance among staff, many of whom hadn't engaged in the mobile arena.

Likewise, one area where attempts to use mobile learning approaches in user-generated content was though use of MMS texts to contribute content to be shared with others via an online service. (Needham & Ally, 2008) This ultimately did not prove sufficiently consistent and scaleable, and relied heavily on continual update and filtering of the MMS messages to remove advertising and transcoding many media formats. Future work in this area will concentrate around using cloud-based services as an intermediary, building on third-party mobile integration. The OU then needs to enable the students to manage and share their content online and via mobile-optimised routes.

3. CONCLUSION

In developing more appropriate mobile learning solutions and services, it is essential that the students are consulted in establishing a strategic roadmap - so that even if design and general operation of mobile-optimised websites were largely unaltered, some useful reprioritisation took place. Taking regular and careful note of the mobile users - both in terms of demographic and technology has also informed the kind of work we undertake, particularly with regard to mobile apps. Finally, ensuring that there are alternative approaches to core activities is key to wider adoption and mainstreaming, which can then lead to more users seeing that mobile solutions are available and work equally well for when they are ready to join in. There will, of course, be specific mobile learning activities that take place in the future, which challenge a distance-learning environment, but can take place if a group is sufficiently well known, similarly equipped, or can be mediated face-to-face.

4. ACKNOWLEDGMENTS

The mobile learning practitioners & community at the OU – http://www.open.ac.uk/mobisite

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Using SIFT (Schematic Instances for Transmedia) to Reflect on a Mobile/Transmedia Module on Games Design

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Abstract

This paper uses a design method called SIFT, which is based on schema theory, to reflect on the possible creation of a mobile/transmedia module on Games Design, which is currently under development. The paper first describes schema theory. Then the SIFT design method is briefly outlined. An illustrative design fragment of SIFT design is then presented, before concluding with a critique of SIFT set in the context of this design fragment.

Keywords

Mobile games, transmedia, education.

1.INTRODUCTION

SIFT (Schematic Instances for Transmedia) was developed out of the author's work on story, games and transmedia (Hale, 2007). This poster details the use of SIFT to undertake the first iteration in the conceptual design of a 'fun' mobile/transmedia module on games design. As at writing, the following material is a 'thought experiment' which will inform the final design of the module. After outlining SIFT, the paper moves on to consider the conceptual design of the module. The paper concludes with a reflective and critical assessment of SIFT as it used in this design context.

2.SIFT

2.1Schema Theory

SIFT makes use of schemas, which are patterns in human conception, perception and memory (e.g. Bartlett, 1932) with 'slots' for content (e.g. Van Lehn, 1980). A schema consists of a name (e.g. 'breakfast'), prototypical slots which define the schema (e.g. 'early morning', 'food') and associated slots which are not necessary to the definition of the schema (Hale and Monk, under preparation) but which are associated with the schema through habit or culture (such as having a drink with breakfast).

2.1.1The SIFT Design Process

There are three iterative and blended stages, which are presented here separately for clarity. The first stage is to list out five types of schemas relating to Users, User Contexts, Delivery Systems, Game Content and Games Experience. For brevity only the top level descriptions are listed in this paper. The game is a mobile/transmedia delivered game which is teaching about design, research and entrepreneurship for digital games (not about mobile or transmedia games *per se*). Mobile/transmedia delivery is used because of the potential value in engaging young people (see for example, Attewell and Webster, 2004), together with an entertainment context, a spatial story made up of micronarratives (Jenkins, 2004, his terminology).

With reference to the Users, these will be undergraduates from multidisciplinary backgrounds, with some knowledge (through playing them) of computer games. The students are expected to have limited knowledge (for this module - a range of modules are still to be developed) of technical design and programming. The first student intake are anticipated to be highly skilled in video technologies.

The User Context includes the geographical space of the campus of the University of Malta. This campus has a number of characteristics, including a highly varied and somewhat complex topography, multiple levels and semi-enclosed spaces, with some road crossing (potential hazard if user is focused on a mobile screen whilst crossing) and heat and light challenges (users may be out in hot and humid weather, high levels of ambient light will affect screen visibility).

Delivery Systems will include mobile telephones, hidden and publicly read documents, objects and university signage (with imaginary 'hidden codes' in). These could be supplemented by seminars, lectures and review meetings, ideally folded into the mobile/transmedia game that delivers the course, so that they become part of the game.

Game Content has four educational elements and a game element (subject to further development by the author and acceptance by the Head of Centre and the University). The educational elements are as follows. Firstly, the digital games context (consisting of genres of games, uses and gratifications approaches, business context and revenue streams). Secondly, the psychology of computer games (digital games as designed/cued experiences, schemas as multi-level cognitive representations, reinforcement protocols and the inductive study of games examples). Thirdly, conceptual design (staged/'agile' design processes, conceptual design prototyping, 'pitch' for the game, story, game control, art work). Finally, entrepreneurship as embodied in a team and focused on a game design project, drawing on the previous elements (setting up a small business, team working in a fictional company for the duration of the module, business structure and business plan, intellectual property issues, business roles within the company, working with outsourced programmers). The game element (the fifth element) is that of a mobile/transmedia quest game.

Once the above schemas have been delineated with names and slots (both prototypical and associated, not done here due to space limitations) the design process moves to the second stage. This consists of parcelling out the Game Content in its detailed specifics across the User, User Contexts and Delivery Systems. These relationships are then delineated in tables in the game documentation. The third and final stage takes the material from the second stage and turn it into a prose description of the desired Game Experience.

3.SIFT DESIGN OF PART OF MODULE

The SIFT design process is now examined for the entry level game play of the module. The game will be focused around a puzzle quest centred on vernacular history, fable and traditional Maltese games. Imagination for creative design is still required, facilitated by the SIFT process as the design is fleshed out.

The entry point for the game (as the Game Content is distributed across User, User Context and Delivery System) might seem to be a university venue and the first formal meeting between lecturer and students (since academic and administrative issues need to be dealt with at the start of the module). Yet SIFT identifies a weakness here, since such administrative and academic issues vitiate the immersion normally inherent in a good game. Identifying this weakness offers the opportunity to rectify it by starting the game after the formalities in the meeting have been dealt with. The entry point into the game is called here, The Setup.

In The Setup, the lecturer has a letter delivered to him by a courier during the first meeting with the students (ostensibly interrupting the meeting). The letter indicates that a national millionaire with an illustrious ancestor has a request of the students: they are to identify the hidden game elements that exist in the topography of the University which have been laid down by the millionaire's ancestor. The millionaire wants to discover and re-create this game, to put it onto the internet and make the students millionaires in the process. The letter concludes by indicating that the students will be contacted by the millionaire's lawyer. SIFT identifies that this game content is delivered to the Users in the User Context of the classroom, with the Delivery System comprising a letter read by the lecturer, brought in by a courier.

Step two follows the reading of the letter: one of the students gets a call on his or her mobile from the lawyer: the students are to proceed to a way point on campus which forms the entry point for the game, where they will receive further instructions. The Delivery System in this step is a mobile telephone, which belongs to a User and is used in the User Context of a group of students, with an unknown caller. The SIFT process reveals that privacy issues arise (users will need to give informed consent for their telephone numbers to be used), plus identifying a duty of care requirement that the call from an unknown caller not be upsetting or embarrassing to the User in the User Context, which here includes a public and social aspect (cultural issues may also come into play in this instance).

The SIFT process is continued with the iterative mapping of Game Content with User schemas, User Contexts and Delivery Systems until all the game elements are mapped out. Since SIFT does not replace creativity, the designer will still have to develop a starting design idea and 'pitch' for the game - but SIFT materially facilitates the deepening and outworking of these. The prose Game Experience description is in practice written iteratively as the design proceeds. The Game Experience is a 'best guess', since players will differ in their individual responses to the game.

4.CRITIQUE OF SIFT AND FURTHER RESEARCH

A number of issues can be identified from this SIFT design fragment. The first is that the lecturer is included as part of the Delivery System (alternatively, the lecturer could be treated as part of the Game Content as a character in the game, which implies a passive agency). This first issue relates to the nature of the story developed during the gameplay, to be considered in the light of 'classical' or 'spatial' approaches to story (e.g. Jenkins, 2004). Secondly, could SIFT inform the initial generation of creative ideas? Further research is needed on the creative mixing of schemas related to genre and story, for the creation of new games. Ethical issues in relation to possible deception will also need addressing. The issue of developing a formal design notation and document from the SIFT process will also be explored. A prime rationale behind the course was to engage the students. As with Attewell and Webster (2004), a series of measures will be used to explore and assess the value of using a mobile/transmedia game in this way. Finally, SIFT as described currently has no mechanism for handling pedagogy. This will be examined as the pedagogic underpinnings are integrated with the module content and the game as both are developed.

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Field Trip Data Collection: Online Data Update versus Synchronisation

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Abstract

In The availability of powerful mobile devices and small, light netbooks with 3G UMTS wireless network connection makes it possible to use such devices to collect and share data on field trips. However you cannot rely on an overall network coverage, especially on field trips in rural areas. In this case you need a backup strategy in order to continue the data collection. Even with 3G network coverage, the use of this service involves additional cost for the user/school/university. This paper discusses and summarises the experiences gained through a three year EU project and the developed solutions to address these issues.

Keywords

Field trip, data collection, synchronisation

1. INTRODUCTION

During our three year Personal Inquiry project a web based application for personal inquiry was tested and developed (Personal Inquiry Project website). The website is optimised for the use with netbooks and in most of the inquiry activities undertaken data collection was involved in classrooms, around school grounds and on field trips away from the schools. This required a range of online and offline data collection techniques to overcome the issues of web connectivity in these environments. These were: online data entry, individual caching and synchronisation, and group caching and synchronisation.

2. ONLINE DATA ENTRY

2.1 Overview

This method adds data directly to the server and therefore needs an internet connection. It is a straight forward approach to data collection: the student opens his/her web browser and navigates to the website to enter their data. This technique has the following advantages:

- The students can edit or delete their collected data and share the collected data with other students.
- Entered data can be validated and can be checked plausibility.
- Collected data can be analysed and presented on the spot; (improves the in situ learning)

However, the online data collection also has drawbacks:

- A reliable internet connection cannot be guaranteed since the data collection in a field trip cannot rely on the availability of a 3G internet connection.
- Unreliable connectivity can cause unpredictable delays, or the collected data can be lost.

Students need devices with 3G mobile network capacity; therefore, with most netbooks additional equipment such as 3G USB dongles or small pocket MiFis (A small WiFi router which is connected via build in 3G modem to the internet) are required.

2.2 Our experience

Connecting groups to the internet via a MiFi router (a mobile, battery powered, 3G to WiFi router) during the field trip has shown to be quite successful in case the individual group members are in a range of about 20 meters of the person carrying the MiFi (Gaved et al., 2010).

3. INDIVIDUAL CACHING AND SYNCHRONISATION

3.1 Overview

In this approach, data collected locally are stored individually on board the mobile device, then later – when an internet connection is available – synchronised with the central server, alongside the data of other participants. The advantages therefore are:

- No internet connection is necessary, providing a self-sufficient package.
- Access is not subject to poor connectivity, providing consistent response times, and less opportunity for data loss in transit.
- No costs of communication need to be incurred in the field.
- Equipment can be configured and tested in advance, without reference to each venue.

The main disadvantages of this solution relate to the use of the mobile device as, in effect, a web server:

- It requires a local application where the data are stored while the netbook is not connected to the internet.
- At the end of the field trip, the data can then be synchronised with the internet server.

The synchronisation task has shown to be a non trivial task.

3.2 Our experience

In our case the netbooks were powerful enough to run a local clone of the web application to locally run a version of the site. This was implemented with the XAMPP server setup (Windows/Linux/Mac, Apache, MySQL, PHP) which allowed for an exact copy (according behaviour) of the server system (XAMPP website).

Students often were using their netbooks until the battery was empty and often forgot to charge them. As a result, the time was reset to the factory default and often not adjusted afterwards. Therefore the synchronisation process was unable to rely on timestamps of the systems; it was impossible to distinguish if data were deleted on the onsite (and the deletion has to be repeated on the main server) or if data were added (and have to be added on the main server too). The chosen solution to this problem was to dictate the *synchronisation direction*, so as a result, data was only added, and not removed.

4. GROUP CACHING AND SYNCHRONISATION

4.1 Overview

During the three year EU project, the 3G network has shown to be not always reliable or available, and access to individual devices was difficult as the students were issued with individual devices to keep throughout each trial period. The synchronisation process has unfortunately shown to be reactively complicated, and the complexity of such a synchronisation process increases with the number of different devices which have to be synchronised. In order to be able to collect data in these cases in the field the synchronisation approach was developed.

In this approach, the students in the field are connected via a local portable WiFi to a local server which has a copy of the internet server while this is in offline or read only state in order to prevent changes. After the field trip, only the local server has to be synchronised (or copied over if no changes were made at the internet server). Unfortunately this approach only works if the students are all close by because the WiFi has a limited range.

4.2 Our experience

The approach to have mobile and classroom group servers has shown to work well. Unfortunately synchronisation with the main server has shown to be quite an involved task. Therefore technical staff were needed to perform the synchronisation before and after each lesson. As a result, in some cases the order of the lessons had to be planned so analysis of the data took place two days after the fieldwork, as synchronisation could not be completed in the intervening time.

5. CONCLUSION

In our case, the best solution has shown to be a combined approach of an online server and the use of local server(s) where no reliable internet connection was available, or was found to be unreliable during lessons. To aid this, keeping the amount of local servers as low as possible by using group servers decreased to synchronisation effort. Future work will improve import/export and synchronisation functionality, so less technical intervention is needed.

While the standard web-application approach uses a browser to submit and access data, this may not be the ideal solution for small hand-held devices such as mobile phones. Although the website is optimised for the use with netbooks, the layout is not suitable most mobile phones. In order to connect mobile devices the development of an application that communicates via a web service with the toolkit is ideal, interacting with the developed application using XML RPC.

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Doctoral Workshop

Towards a better understanding of the role of culture in the adoption process of mobile learning practices in higher education. A case study focused in Mexico.

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Abstract

The adoption and diffusion of new technologies, i.e. the rate at which they are adopted and incorporated into the productive process, is considered as one of the main triggers to enhance a country´s economic growth (Rogers, 2003; Rosenberg, 1972). In this regard, several models have been developed to test the IT adoption rate of individuals as the Technology Acceptance Model (TAM) by Davis (1989); however, no clear relationships have been established between cultural variables and IT adoption factors. This study examines the effect of culture on the students´ acceptance of mobile learning practices in higher education through the social influence variable of a research model based on the Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh et al (2003). The proposed model will be tested with a convenience sample (Lunsford & Lunsford, 1995) of higher-education Mexican students.

Keywords

Innovation, adoption, culture, mobile learning, higher education.

1. INTRODUCTION

The adoption and diffusion of new technologies are not equally adopted by individuals of different cultures, that is to say, there is not a standardized pattern of innovation adoption worldwide. Directly affecting these adoption rates are both economic and non-economic factors. In reference to the economic factors, previous studies have pointed degree of openness to trade, economy growth, levels of income, and human capital endowment, among others, as the major factors influencing adoption decisions (Comin & Hobijn, 2004; Hall & Khan, 2003; Caselli & Coleman, 2001). However, there is evidence that countries with similar economic backgrounds vary significantly in terms of adoption rates (Van Ark, Inklaar, & McGuckin, 2002; Meijer & Ling, 2001). Consequently, this variation may be attributed to the non-economic factors in each country, where national culture plays indeed a significant role.

There are several studies evidencing this variation in adoption rates among countries with similar economic development. As instance, Meijer & Ling (2001) highlight a large difference in mobile phone and internet adoption in the study they conducted along nine European countries. On their side, Van Ark, Inklaar, & McGuckin (2002) state that the proliferation of information and communication technology has been faster in US than in EU even though their industry patterns are alike. Therefore, it may be deducted that economic conditions are not the only factors determining the cross-country variations in technology adoption, but also the diverse factors represented by each country´s national culture. This issue has however received little attention in the body of literature so it leads us to posit the following research question for this study:

"What is the influence of the cultural factors in the adoption process of mobile learning practices among Mexican higher-education students and how this influence may be interpreted in order to enrich the teaching-learning process?"

Several authors have offered their own definition of culture in the past. According to Bates & Plog (1980) culture is defined as "the system of shared beliefs, values, customs, behaviors, and artifacts that the members of society use to cope with their world and with one another, and that are transmitted from generation to generation through learning". For the purpose of our study, it is also important to explore the concepts of technology and innovation. Both are wide concepts which have been defined from the perspective of several fields of study. In our case, technology will be exclusively referred to the use of 3G mobile devices, i.e. wireless voice telephony and broadband wireless data, all in a mobile environment. As of innovation, it will be referred as the capability of students to receive and manipulate learning contents in their respective 3G mobile devices.

2. THEORETICAL BACKGROUND

The central objective of this investigation is to determine how a cultural dimension can be incorporated into the existing models of technology acceptance. The Technology Acceptance Model (TAM) first proposed by Davis (1989) and later validated in several disciplines by many other researchers, seems to be the most widely accepted model in studies related to the consumer adoption behavior of new information technologies. Even though, some authors are reluctant to accept it as theory due to its triviality, lack of practical value, and limited explanatory and predictive power (Chuttur, 2009). The neglect to include group, social, and cultural aspects of decision making is another particular shortcoming of TAM (Bagozzi, 2007).

In an attempt to enhance the original TAM´s proposition, Venkatesh and Davis (2000) formulated a second version of the model which they called TAM2 being intended to explain both Perceived Usefulness and Intention to Use in terms of social influence and cognitive instrumental processes. This model was tested by the authors under both mandatory and voluntary conditions finding that results strongly supported its predictability. TAM2 includes the social influence factor in terms of the subjective norm variable so this characteristic opens the possibility to include cultural factors in the construction of our model.

Most recently, Venkatesh et al (2003) examined eight different models related to the explanation and prediction of the acceptance and use of information technology by end users. Based upon the constructs examined on each individual model, they created a single model called The Unified Theory of Acceptance and Use of Technology, i.e. UTAUT which was found to outperform and to be more predictive than any of the single models alone. This model unites the principles of the Theory of Reasoned Action (TRA), the Motivational Model (MM), the Model of PC Utilization (MPCU), the Innovation Diffusion Theory (IDT), the Social Cognitive Theory (SCT), the previously discussed Technology Acceptance Model (TAM), the Theory of Planned Behavior (TPB), and a model combining these last two (C-TAM-TPB).

The UTAUT considers the following four factors that determine Use Behavior either in a direct or indirect way: Performance Expectancy, Effort Expectancy and Social Influence through the mediator variable Behavioral Intention, and Facilitating Conditions acting directly. This model also includes Gender, Age, Experience and Voluntariness of Use as moderating variables.

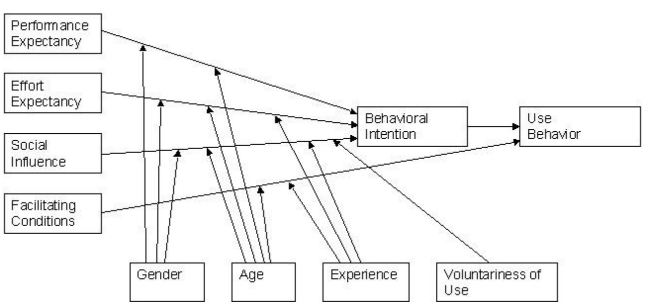

Figure 1: Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh et al., (2003).

This model is quite complete and robust due to it reunites the principles of eight different models related to the acceptance and use of information technology. It also includes Social Influence as one of the variables explaining the variance in users´ acceptance of technology which bring us the possibility to consider cultural aspects as one of the determining factors on students´ acceptance of mobile learning practices. Besides, the UTAUT model considers the Facilitating Conditions variable which is relevant in our case to properly measure the institutional support that students receive when being involved in the use of mobile learning activities. Consequently, UTAUT seems to be the most appropriate model to take as a base in the construction of our own research model for mobile learning ambiences.

3. RESEARCH MODEL

The Social Influence variable in the UTAUT model is the mean to consider cultural influences on intentions to use technology. These influences are referred to organizational culture in the original model; however the consideration of additional factors such as people´s cultural background may enhance the predictability of the UTAUT model. In our research model it is posited that students´ cultural background is an important factor to determine their Behavioral Intention toward the adoption of mobile learning practices.

Another important element to consider in our research model is the way students prefer to learn as well as the techniques professors use to teach. As posited by Umrani-Khan & Iyer (2009), the e-learning practices are associated with individualization of the teaching-learning process so the learning style of the student and the teaching style of the professor are both important factors affecting the adoption process. In a UTAUT-based new model these authors proposed for e-learning environments, they considered learning style and teaching style as mediator variables affecting the relationship between performance expectancy and behavioral intention toward the use of e-learning practices. Being mobile learning an extension of the e-learning methodologies, it is suitable therefore to include these 2 variables as part of our research model considering the same mediator effect.

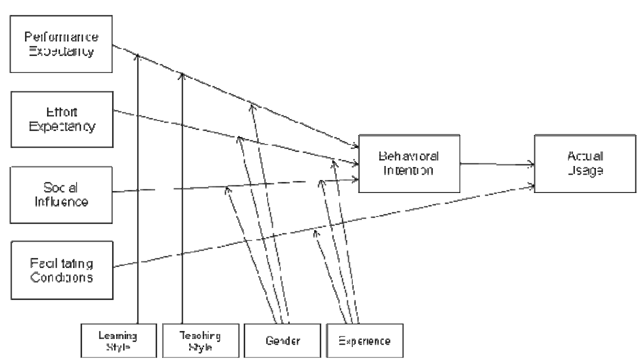

Figure 2: Proposed research model for mobile learning environments.

As we can see in the previous figure, our adapted UTAUT model for mobile learning environments proposes that Performance Expectancy and Effort Expectancy will affect the Behavioral Intention of students to adopt mobile learning practices, with Learning Style and Teaching Style acting as moderating variables between Performance Expectancy and Behavioral Intention. Besides, it is posited in our model that the Social Influence variable, which includes the subjective norm based in culture, will provide additional explanatory power concerning students´ Behavioral Intention to adopt mobile learning practices. The Facilitating Conditions variable included in the original UTAUT model will also be considered as direct agent affecting the students´ Actual Usage of mobile learning activities.

Regarding the 4 moderating variables included in the original UTAUT model (Gender, Age, Experience, and Voluntariness of Use), two of them will not be considered. The fist not-considered variable is Age because it is expected that higher-education students, the sample population of our study, are all young people oscillating in the same range of age. The second not-considered variable is Voluntariness of Use because mobile learning activities are supposed to permanently be non-mandatory to use for the students involved in our study, being just an extra academic tool during their learning process. The other two variables, Gender and Experience, are both considered relevant to be included in our research model having the same moderating effect proposed in the original UTAUT model.

4. PILOT PROJECT

A pilot project was conducted in a higher-education Mexican institution with a research methodology based in a deductive approach using a mix of 5 deep semi-structured qualitative interviews and 76 quantitative surveys. The interviews were conducted with 3 mobile learning specialists (the co-leader of the mobile learning project at the institution and two professors who have included mobile learning activities in their courses) as well as with 2 students. The questionnaires were applied to 76 students out of the 217 who were invited to participate.

5. RESEARCH PLAN

The planned schedule for our research project is based on the outcomes of the pilot project. The different phases as well as the time frames considered for its completion are shown in the following table and explained below:

Table 1. Research plan

Milestones	Time
Literature review and project proposal update	Done
Research model update	Done
Questionnaire modification and testing	3 months
Design of the field study	3 months
Data gathering	6 months
Data coding and analysis	3 months
Final document writing and revisions	9 months
Total length	24 months

5.1 Literature Review and Project Proposal Update.

As per the outcomes of the pilot project, some modifications were needed to be done mainly in the redefinition of the research focus being now centered just in the mobile learning practices. As consequence, an update on the literature review was also needed including a more comprehensive revision about the models of technology acceptance and the consequent update of our research model.

5.2 Research Model Update.

Our new UTAUT-based research model, as detailed before on this document, now includes the proper variables to measure the students´ adoption decisions in mobile learning environments like cultural factors, students´ learning style, professors´ teaching style, and others belonging to the original UTAUT.

5.3 Questionnaire Modification and Testing.

The conception of an updated research model implies the appearance of new variables and thus the formulation of new questions and modification of some of the previous ones. As a result, a new questionnaire will emerge which will be properly tested before applied to the final sample of students.

5.4 Design of the Field Study.

Determination of the logistics to conduct the study as: sample size, institution to carry out the investigation (already selected), ways to invite students to participate, time frames to collect data, follow up on the answering process, software to utilize and technical contingency plans.

5.5 Data Gathering.

The specific process of collecting data based on the logistics described in the precedent point.

5.6 Data Coding and Analysis.

Codification and cross-variable analysis of the collected data aimed to test the hypothesis of the study.

5.7 Final Document Writing and Revisions.

Detailed explanation of the different stages of the whole research process, ending by the compilation of findings and conclusions. This is conceived to be an iterative process with my supervisor.

6. RESEARCH CONTRIBUTION

Multiple models have been used to attempt to predict or explain the individuals´ acceptance and use of technology. Nevertheless, most of these studies have been conducted in developed countries, mostly in the US and Canada were similar conditions prevails. This study proposes to test a model of technology acceptance in Mexico, a country with a cultural setting that varies significantly from those in which the majority of technology acceptance models have been tested.

Besides, mobile learning, or the use of mobile devices to deliver educational contents, is considered an innovation in the higher-education sector of Mexico. Thus, the outcomes of this investigation will contribute to the creation of suitable pedagogical methods to enhance the development of this innovative educational tool. Through the better understanding of the cultural factors, and others as well, affecting the students´ adoption decision processes, educational practitioners will be in a better position to develop this new and innovative way to deliver education. To the best of the authors' knowledge, no previous research has been conducted on this particular area.

7. RESEARCH LIMITIATIONS

There are some limitations of this study that must be taken into account when considering applying the findings and conclusions to universities where students are clearly immersed in different cultural settings. The research model proposed in this study, however, may be used as a base to start exploring the students´ adoption decisions in educational institutions related with the implementation of mobile learning practices.

In addition, by selecting the students of one specific educational institution in Mexico as the population for this research, it is understood that this is a convenience sample where the students are of a convenient accessibility to the researcher (Lunsford & Lunsford, 1995). Due to the cooperation of this educational institution, the ease of accessibility to its students will importantly reduce the time and cost necessary to carry out this investigation. However, the disadvantage of a convenient sample is the possibility of bias in the sample population as well as it may not be representative of the whole population of higher-education students in Mexico.

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To both my supervisor and administrators of the doctoral program I am actually enrolled in (Doctorate of Business Administration joint degree between Grenoble Ecole de Management in France and Newcastle University in UK). The great support I have received from them has been crucial for my progress until now.

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Investigating Design Principles for Mobile-Assisted Language Learning Objects: Design-Based Research

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Abstract

This paper introduces a Design-Based Research study which addresses the problem of inadequate aural skills instruction for college second language learners by investigating the design of Mobile-Assisted Language Learning (MALL) interventions. The current longitudinal study aims to generate design principles for MALL learning objects enabling the development of listening skills. Through the iterative process of design, development and evaluation, mobile learning objects have been created and tested on students' mobile devices. The theoretical framework and findings of the first two phases of the study are discussed.

Keywords

Mobile-Assisted Language Learning, design principles, DBR

1. Research Background

The doctoral research project introduced in this paper builds on the findings of the study conducted at George Brown College, Toronto, Canada, between 2007 and 2009. The study revealed a critical need for ESP (English for Special Purposes) support, particularly speaking and listening. Mobile learning was subsequently identified as the appropriate solution to augment ESP classroom learning by expanding it into the real-life context (Palalas, 2009). A number of advantages and caveats of Mobile-Assisted Language Learning (MALL) were isolated which indicated that participants preferred to rely on the inherent audio capabilities of the mobile devices rather than text-based options, and that, of the four language skills, listening was the skill best addressed via students' mobile devices. It was apparent, however, that the audio podcasts developed for the pilot were not sufficiently engaging or interactive. The impact of the audio and video content was not exhaustively investigated, nor was the actual learning adequately evaluated.

To further pursue investigation of the effective design of MALL activities addressing listening competencies, and to answer questions pertaining to content design and delivery which would help understand the interplay of the technical and pedagogical aspects of MALL, a longitudinal Design-Based Research (DBR) study was launched in November 2009. The first two phases of the four-phase DBR study have been completed generating findings which will inform subsequent refinements to the MALL learning object[1] (LO) design.

2. Research Purpose and Question

The current DBR study aims to produce a set of principles guiding the design of MALL listening instruction for English language learners in their unique context. In addition, the study seeks to design and develop listening learning objects to be used on students' mobile devices. The MALL LO prototypes have been developed and will continue being refined through the iterative process of the design, development and evaluation. Design principles for these LOs will be formulated on the basis of the participants' feedback and language assessment, juxtaposed with the analysis of the design process and the learning objects themselves. Most importantly, the research is guided by the current second language learning pedagogy. Through the design of an innovative learning solution, the project will thereby "enable […] us to create learning conditions that learning theory suggests are productive, but that are not commonly practiced or are not well understood" (Design-Based Learning Research Collective, 2003, p. 1). Consequently, it will provide guidance to ESP practitioners and thereby "integrate the development of solutions to practical problems in learning environments with the identification of reusable design principles" (Herrington, McKenney, Reeves, & Oliver, 2007, p.1).

The proposed DBR study seeks to answer the following question: What are the characteristics of an effective pedagogically sound learning object for students' mobile devices through which adult ESP students in a community college enhance their listening skills while expanding their learning outside of the classroom?

This rather complex question warrants further elaboration here. The critical aspects of this question revolve around what constitutes an effective pedagogically sound learning object. For the purposes of this study, pedagogically sound refers to design informed by constructivist learning theories, and more precisely Ecological Constructivism, a theory of learning, which according to Hoven and Palalas (in press), melds Social Constructivism, Sociocultural Theory and Ecological Linguistics. The effectiveness of the objects is measured both by ESP learners' progress as well as participants' satisfaction with the LO's design and the learning experience. To what extent classroom learning can be augmented in the real-life setting will be also measured by student performance on the Canadian-Language-Benchmark-based language proficiency tests.

[1] To provide a "container" for the instruction chunks deliverable via mobile devices, the term "learning object" is used here, following the concise definition by Ally (2004b): "any digital resource that can be reused to achieve a specific learning outcome" (p. 3).

The research question therefore inquires about the characteristics of an effective MALL learning object, the critical elements of the whole solution and the relationships between its constituents. This innovative mobile-assisted educational intervention has been studied in the context of a community college where ESP learners use their own mobile devices to complete MALL pedagogical tasks. An overview of the study method and up-to-date findings are presented after a brief discussion of the theoretical framework guiding the investigation.

3. Theoretical Framework

An in-depth literature review was conducted as part of the first phase of the DBR study, namely Informed Exploration (Bannan, 2009). It encompassed research on aural skills, Second Language Acquisition (SLA), mobile learning with an emphasis on MALL and mobile learning objects as well as literature on CALL (Computer-Assisted Language Learning). Initially, the Sociocultural Theory (SCT) paradigm (Lantolf, 2000) provided an overarching framework to govern this interdisciplinary study. Having stemmed from Vygotsky's theory of Social Constructivism, SCT integrated the elements of socially and culturally constructed mediation, goal-oriented learning, the Zone of Proximal Development (ZPD) and a community of practice (Vygotsky, 1978). Similarly to aural-skill-oriented literature, interactivity was identified by SCT as sine qua non: for learning to occur, repeated interaction with the context and other people is needed. In order for the learner to achieve independent performance, such interactivity should be combined with the scaffolding support of a facilitator or peer (Vygotsky, 1978). SCT emphasizes that language meditates learning, and so does technology. In fact, mobile technology as a socio-cultural artifact serves as a tool facilitating communication and potentially enabling language learning; like language, the technology enables a mediated relationship with others and the world.

That interconnection with the context and its elements had to be investigated further. Consequently, the study adapted an ecological perspective which views knowing as an evolving process enabled by the dynamic and fluid connections made possible through mobile technologies (Hoven & Palalas, in press). According to the Ecological Constructivist view of language learning, knowing is construed from and through interactions and by acting on affordances available in the environment in which learners operate and collaborate across dynamic networks (Hoven & Palalas, in press). The notion of situated learning is thus another relevant element of the theoretical approach of the study.

1.1 Mobile-Assisted Language Learning

Derived from mobile learning literature, previous studies at GBC and the above presented theoretical framework, our definition of MALL has also evolved. Accordingly, MALL is defined as "language learning with handheld devices, enabled by the mobility of the learner and location, portability of devices (Kukulska-Hulme, 2005; Mwanza-Simwami, 2009; Naismith, Lonsdale, Vavoula, & Sharples, 2004), human interaction across multiple situations (Sharples et al., 2007) mediated by mobile technology within a networked community of practice (Sharples et al., 2007), embedded in contexts which are relevant and pedagogically sound (Laurillard, 2007) and informed by the real-life context in which the learning takes place" (Palalas, n.d.).

Mobile-Assisted Language Learning literature has demonstrated that mobile technologies are perceived as helpful and appropriate for language teaching and learning (Kukulska-Hulme & Shield, 2008). Language is contextually contingent and therefore the mobility of the learner across diverse authentic contexts potentially enables situated language practice. On-demand interaction with teachers, experts and peers offered in a more self-paced collaborative environment can further promote learning. Additionally, Kukulska-Hulme and Pettit (2009) mention convenience utilizing downtime productively, access to resources and materials, as well as multimedia options. Mobile technologies also allow for organizing learning into ''manageable chunks'' (Chinnery, 2006), and reinforcing oral and aural skills (Abdous, Camarena, & Facer, 2009). Rosell-Aguilar (2007) revisits several MALL studies and completes the list with the advantages of attractiveness, motivation, and access to resources integrating in-class and out-of-class learning.

Some of the most frequently identified caveats of mobile devices, reported in research and experienced by the College students, are excessive mobile phone and data plan expenses, limited Wi-Fi access, small screen sizes, difficulties typing on small devices, and a short battery life. Mobile devices can enable interaction; however, the resulting communication may be less meaningful due to the limited depth of thinking and learning, distraction, and everything having to be "short and small" (Kukulska-Hulme & Shield, 2008). These and other aspects of mobile technology identified in the study and summarized below have been factored into the design of our MALL activities.

1.2 MALL Design Principles

Literature offers some guidance regarding the design of MALL instruction addressing aural skills. Following SLA, CALL and MALL principles, tasks must be contextualized, interactive, collaborative, and learner-centred. They should encourage students' participation, and at the same time challenge their language competency. MALL activities have to lessen the isolation of the mobile language learner and compensate for the lack of paralinguistic cues as well as the increased probability of ambiguity (Hampel, 2003). Effective aural tasks should offer comprehensible input and generate opportunities to produce modified output. In addition, Rosell-Aguilar (2005) suggested that effective mobile tasks have the following main features: (1) they are relevant to students' goals, (2) promote real and meaningful communicative practice, (3) offer corrective feedback, scaffolding instructor mediation, and opportunities for questions, (4) are organized around a communicative goal, (5) present contextually contingent lexico-grammar, and (6) use authentic materials.

The above recommendations have to be regarded alongside with mobile learning object design principles recommended by literature. Patokorpi et al. (2007) propose the following essential qualities of mobile learning objects: small, intelligible, object-like, interoperable, expedient, situated, immediate, persistent, reusable, personalizable, and manipulable. Similarly, Ally (2004a) emphasised that materials should be presented with the limited size of the screen in mind and chunked into small pieces; intelligent systems should be used to enable adaptation to an individual learner's profile and needs. Ally adds that multimedia information-rich methods should replace text where possible and he further elaborates on mobile design principles which can optimize usability and information presentation.

To distil the most pertinent requirements and features of the MALL learning object, the DBR approach has been adopted for the study, thus enabling iterative feedback analysis and reflection through a practical lens.

4. Design-Based Research (DBR)

In order to address the complexity of the context and ensure a systematic approach, a proven comprehensive four-stage DBR model has been adopted, i.e., the Integrative Learning Design Framework (ILDF) (Bannan, 2009). This dynamic model comprises four phases which repeat and often overlap: (1) Informed Exploration, (2) Enactment (3) Evaluation: Local Impact, and (4) Evaluation: Broader Impact. The last phase is out of scope of the current study.

Informed Exploration included closer audience characterization, further literature review, investigation of comparable mobile learning solutions and feedback collection via interviews with experts, language learners and teachers. The resulting theoretical construct guide the design and development of MALL LO in the second phase.

During Enactment, prototype MALL listening learning objects were created in collaboration with the School of Design and School of Technology students and professors. The prototypes underwent a series of preliminary tests with second language learners. Feedback from practitioners and students was collected through class meetings, interviews, focus groups, email correspondence and Elluminate meetings. All data were documented through LO design and development documentation, researcher's field notes, audio files from Elluminate meetings, and written communication records.

Evaluation within a local context commenced in September 2010 and has encompassed implementation, formative testing, evaluation, and the refinement of the design principles and the MALL learning objects. Over 60 students are currently involved in piloting of our MALL activities. Students' feedback will be collected through surveys, mini-surveys built into the LO themselves and through interviews. The effectiveness of the LOs will be also measured by pre- and post-test using the CLB-based language proficiency tests.

Throughout the three phases stretching over five sessions of 15 weeks, both qualitative and quantitative data will be collected and analyzed. Thick description of the study will enable transfer of usable knowledge to other settings. The study also aims to engage and thus empower both practitioners and students.

1.1 Preliminary Findings: Summary

Based on the interdisciplinary feedback collected from language learners, student designers, student programmers and practitioners, the following elements are deemed critical for MALL LOs to enable effective development of listening skills: (1) authentic communicative tasks which engage and motivate, and which are embedded in the real-life setting, (2) audio podcasts providing task directions, task-related linguistic and non-linguistic information, (3) student-created audio podcasts and/or multimedia artifacts, (4) access to language resources (web-based or locally residing), (5) a "mobile" community of practice forming a network through which students and facilitators can both socialize and provide support (linguistic, methodological and technical), (6) tools to exchange student-generated multimedia artifacts (upload and download options), (7) listening practice integrated with the other language skills, (8) just-in-time and delayed scaffolding as well as task-related guidance, (9) options enabling interaction with the environment (such as voice recording and camera) or pointing to such built-in capabilities of the mobile device, (10) and most importantly a choice of tools, resources and communication channels selected by experts and organized around the pedagogical task yet accommodating technologies to which students have access. Furthermore, Mobile-Assisted Language Learning should integrate opportunities for dynamic processing of pre-planned content combined with impromptu communicative exchanges "emerging from a person's situatedness or participation in a physical and social world" (Kramsch, 2002, p. 11).

1.2 Next Steps

As mentioned above, drawing on these findings a set of prototype solutions was developed and is being currently tested by second language learners at the College. Subsequently, the MALL design under study will be further refined and tested. Essential characteristics of effective LOs will be thus distilled in a circular fashion to capture the critical elements of the mobile learning solution and their relationships. Informed by interdisciplinary feedback and multiple cycles of design, development and evaluation, the resulting substantive and procedural knowledge will be eventually formulated into a MALL listening LO design framework.

5. Conclusion

In summary, there are a number of challenges inherent in the complex nature of the DBR methodology; it is lengthy, multilayered, and sometimes “messy”, it involves numerous actors and a multitude of concurrent micro and macro processes. Nevertheless, it has proven to be an effective approach in this longitudinal study and one providing invaluable feedback from both practitioners and learners. Being embedded in the real-life context, this research study has espoused practical MALL solutions addressing existing ESP instructional problems.

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Technology Disturbed Learning[1] in Mobile Contexts

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Abstract
Formal outdoor learning activities supported by mobile devices are commonly designed as one-time events, lasting only a few hours. In this short time students are asked, not only to solve some task outdoors but also to learn to cope with many conditions of the activity new to them. This paper questions the design of mobile learning activities that lead students to focus on the mobile devices at the expense of interacting with other students or exploring the outdoor environment. This paper asks how mobile learning contexts could be conceptualized to clarify the problem of balancing focus on devices and suggests that part of the answer might be found in the concept Augmented Contexts for Development.

Keywords
Mobile Learning, Design Research, Interaction Design, Context, Augmented Contexts for Development, Focus on Devices

1. INTRODUCTION
Interaction design is a research field looking to develop technology for social human actors instead of individual users. From an interaction design perspective, mobile learning research initially is about how to design mobile devices for learning. However, with increasing degrees of mobility, designing mobile devices has to take more and more of the learning context into consideration. Taking the context into consideration can be done both by letting the mobile devices adapt to changing contexts and by designing learning activities supported by mobile devices among other tools and structures. In the relatively stable context of everyday classroom learning, students can adjust to what they think is required from them and what behavior is expected. In comparison, mobile learning contexts are lacking many elements that help structure the classroom learning, the students are familiar to. When the mobile devices are used to provide structure and control that is lost when moving out of the classroom, these mobile devices become the center of attention. If the mobile devices are there in support of another activity, for example to guide students to certain aspects of an outdoor environment, strong focus on the devices is a problem. Instead of technology enhanced learning what we have designed is technology disturbed learning (see Figure 1).

A recent critical review paper reports that roughly one third of mobile learning research projects strive to move learning away from the classroom to more natural contexts (Frohberg et al., 2009). In the same review paper the authors noted that there is "very little work which discusses the placement of mobile tools as means of control" (p. 318) and that "[v]ery few Mobile Learning projects with physical context explicitly considered, positioned or focused the usage of mobile technology as instruments to gain transparency and steer flexible learning activities there." (ibid, p. 318). As noted in these research projects the field trials are done with small groups of students to facilitate collaborative learning. Some of these projects use mobile devices to not only present information about tasks to users, but also to control the flow of the learning activity in detail. This type of design is related to device-centric approaches that bring small groups of learners to maintain a strong focus on devices and device interaction. It is notable that strong focus on the devices are just reported in peripheral notes in research reports from these projects, and consequently strong focus on devices is seldom questioned or understood as a main research problem (Göth et al., 2006). This leads to the following research question:

Figure 1: Technology Disturbed Learning?

1.1 Research Question
How do we design for *mobile learning contexts* where students are able to balance their focus between mobile devices and the educational tasks at hand?

For this Doctoral Workshop the tree sub-questions on (1) design research (2) mobile learning contexts and (3) how to balance focus on devices are all of interest, but I specifically want to discuss how the "mobile learning contexts" can be conceptualized to allow for a specification of the problem of designing for a balanced focus on devices.

[1] Special thanks to the participants at NORDITEL 2010 for discussing the concept of 'Technology Disturbed Learning' as opposed to Technology Enhanced Learning.

2. METHOD

In approaching the research question we designed and implemented mobile learning activities, by adopting design practices from design-based research (Design-Based Research Collective, 2003), where we relied on co-design (Penuel et al., 2007) for the design iterations (see Figure 2). By design practices we refer to working in iterative cycles together with teachers in creating a prototype and later a product that can be tested and eventually deployed in schools. The Design-Based Research Collective (2003) argues that design-based research blends empirical education research with the theory-driven design of learning contexts. Design-based research has proven a suitable methodological approach for the field of mobile learning, since design-based research attempts to combine the intentional design of interactive learning contexts with the empirical exploration of our understanding of these contexts and how they interact with the individuals (Hoadley, 2004). Design-based research follows an iterative cycle of identifying, developing, building and evaluating similar to interaction design processes and other software development processes.

The Design-Based Research Collective (2003) discusses design research in education and states that "[t]he challenge for design-based research is in flexibly developing research trajectories that meet our dual goals of refining locally valuable innovations and developing more globally usable knowledge for the field.". In this definition the innovation is what we want to focus on. By innovation we understand that the context for learning is changed compared to the previous learning context.

The two design research iterations have to a large extent been based on analysis of empirical data. In line with design-based research, we let theory inform the next design iteration. One step towards a third design iteration that is more theory-driven is to conceptualize mobile learning contexts from a design perspective. To make the conceptualizations relevant to the problem of focus on devices we discuss mobile learning contexts in relation to interaction design.

3. CONTRIBUTION TO THEORY

Kukulska-Hulme et al. (2009) argues that European research projects on mobile learning have one concept in common. By describing a number of projects they have been part of, they qualify *context* as the overarching concept for mobile learning research. In discussing location-based and contextual mobile learning, Brown et al. (2010) notes that a key issue for design is whether to use explicit or implicit models of context. How to design for context has also been an issue much debated in the interaction design research field.

Context was introduced to interaction design research from the context-aware computing field. In context-aware computing representing and modeling context is seen as a prerequisite for designing context-aware systems. The assumption is that it is possible to divide the context of a user into smaller parts and that some of them are more or less objective and stable. Thereby it is possible to meaningfully represent them in a computer system the user is interacting with (Dey et al., 2001). The problem with context-aware computing is that the user context and the system model of the context will diverge as soon as the context-aware system is put in use. The context-aware computing solution to this divergence is either to add an exception to the model every time it diverges or to trust in future advancements in artificial intelligence to solve the discrepancies. Despite these challenges, the context-aware computing approach has also been prominent in mobile learning research (Lonsdale et al., 2004, Kurti, 2009).

This computer science perspective was met by the embodied interaction perspective, where context is not some delineable aspect of a setting that can be encoded and explicitly represented (Dourish, 2004). Rather context is something people do. In this way the context model in embodied interaction is an interactional model and not a representational model (Dourish, 2004). The problem with an interactional model of context is that it does not give enough guidance for designing computer systems as context cannot be represented (Chalmers, 2004). In that way embodied interaction gives a descriptive model of context, which might be used for analysis, but it does not give input to design. Despite these challenges, embodied interaction is referred to repeatedly in mobile learning research (Pachler et al., 2010).

A conceptualization of mobile learning contexts relevant to interaction design can lead to enhanced learning and help clarify the problem of focus on devices, but it is still an open question if the answer is to be found in context-aware computing or in embodied interaction or in a combination of the two (Eliasson et al., 2009, Brown et al., 2010). At the same time a conceptualization of context is closely related to the problem of focus on devices.

4. CONTRIBUTION TO PRACTICE

Our design research process (see Figure 2) is framed within a project designing learning activities on geometry across indoor and outdoor contexts, with mobile devices used as support in the outdoor activities. We have iterated the design in two steps together with teachers in creating learning activities that tries to take all stakeholders into account.

4.1 Design of Learning Activities

The students worked with the concept *volume* in the first design of the geometry-learning activity and in the second design iteration the students worked with the *area* concept. In the first design the scenario was that the students played the role of architects planning for new buildings and the scenario for the second design was that an imaginary, almost extinct, spices needed to be relocated from the local zoo to a field close to the school (see Figure 3). The task

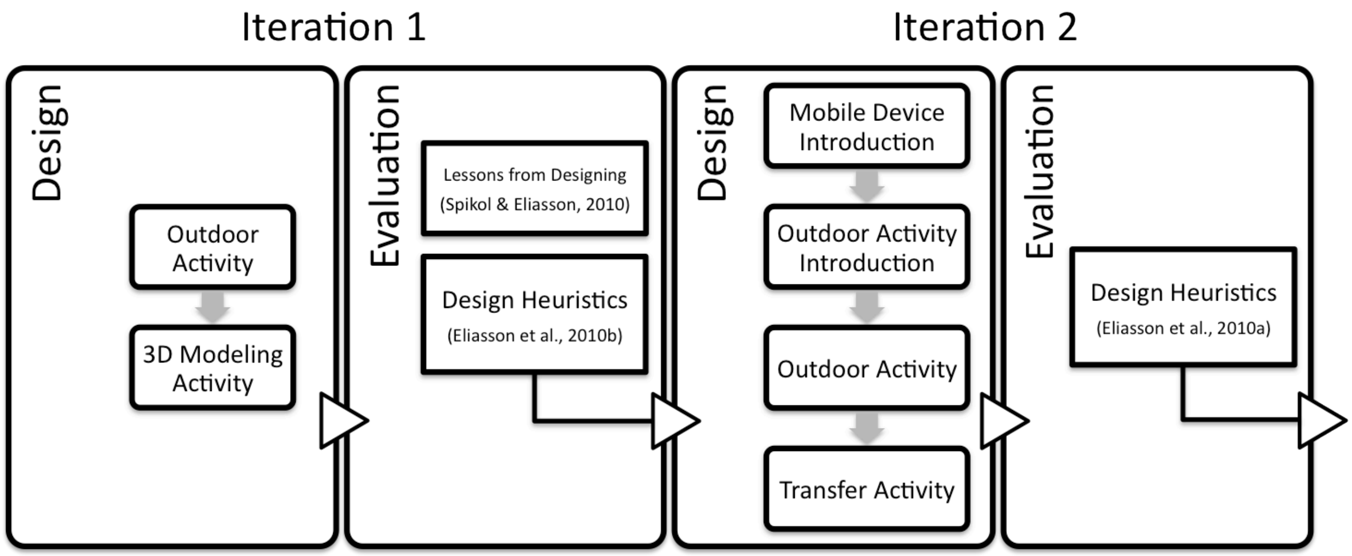

Figure 2: Design Research Process

for the students was to see to that the new enclosures for the animal had the right measurements.

In the learning activities the students worked in groups of three, where each group used two mobile devices. Measuring large distances and areas required the students to use our mobile software application, which measures the distance between two mobile devices using GPS. Apart from measuring, the mobile devices presented students with tasks based on were they were located and where they were in the task structure. The mobile devices were also used for submitting answers, displaying clues and providing feedback.

Figure 3: Small and Large Rectangles in the Second Design

The outdoor activities of the second design started when the students were handed the mobile devices. One of the mobile devices informed them to go to a small field nearby, where they were asked to guess the area of two small rectangles marked by plastic cones. The rectangles had different length and width, but were both 12 m^2. Each group had prepared one 1x1 meters cardboard square to measure the areas. After a completed task they would send the answer to receive a new task. When they had guessed and calculated the areas correctly they received a message on the task device to go to the big field. In the big field they were first asked to guess the area of the large rectangle (4000 m^2) and then to measure the area. The student groups calculated the rectangle by measuring each side of it using the mobile devices and multiplying the two sides. The students' last task was to go to a third field to create their own rectangle with the area 4000 m^2. Through the field tasks there was a progress from measuring small areas with the cardboard square, to measuring large areas with the mobile devices and finally to construct an area.

4.2 Evaluation of Focus on Devices

We evaluated the second design of the learning activities through analyzing two outdoor activities, each held with two groups of three students. The outdoor activities were set within the frame of other learning activities, both indoors and outdoors. The analysis of visual focus on devices rests on interaction analysis (Jordan and Henderson, 1995) for the identification of relevant episodes and the task model (Sharples et al., 2007) for analyzing individual episodes. The outcome of the first evaluation were lessons from the design process (Spikol and Eliasson, 2010) and a set of design heuristics (Eliasson et al., 2010b) that were fed into the second iteration and refined in the second evaluation. The refined design heuristics are stated as (Eliasson et al., 2010a):

The mobile devices should:
- *Let students assume roles*
- *Be used by students as measuring tools*

The mobile learning activities should:
- *Require physical interaction with the environment*
- *Let teachers assume roles*
- *Encourage face-to-face collaboration*

The learning activities should:
- *Introduce unfamiliar aspects of the mobile learning activity before going into the field*

5. CHALLENGES

The design heuristics above were developed through analysis of empirical data rather than from an elaborated conceptualization of mobile learning contexts. To refine the design heuristics further and to guide future design iterations a conceptualization of the mobile learning contexts is needed. This conceptualization should match the formal learning activities we study, be concrete enough to inform design and still broad enough to include aspects of mobile learning contexts ranging from the design of mobile devices to introductory activities, that are closely related to the mobile learning activities, but might not use mobile devices directly.

One possible conceptualization is Augmented Contexts for Development (ACD) (Cook, 2010b), which is introduced as a concept to narrow down the scope for design research in mobile learning. ACD builds on the Zone of Proximal Development (ZPD) (Vygotsky, 1978), and places context as a core construct of the ZPD. When doing so, Cook (2010b) identifies the "situated and temporal dimensions of attention and perception" (p. 6) as key for ACD. This leads to the question how the temporal dimension can be designed for and especially how the "positive and deficit aspects of attention [can] be designed for" (ibid, p. 7). At a recent talk on how to design for mobile learning contexts, Cook ads a clarification that "a 'fancy' interface may distract from learning." (Cook, 2010a).

It is encouraging that the line of reasoning on ACD presented in Cook (2010b) leads to a question very similar to that of balancing focus on devices. In addition ACD helps to connect the ZPD to mobile learning contexts and on to the problem of focus on devices. With this said it should be noted that ACD is still an emerging concept, and its' relation to the ZPD is in no way final. What remains is to see how ACD can clarify the problem of balancing focus on devices in mobile learning and what other conceptualizations can contribute.

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Tutorial

Tutorial proposal for mLearn 2010 conference

INVESTIGATING STUDENT-CENTERED SUSTAINABLE EXPERIENTIAL M-LEARNING.

Length of tutorial 3 hours

Facilities required Room with wireless internet, PC and data projector. Other resources provided by Facilitators

Maximum number of participants 50

Intended audience and degree of expertise required by participants
mLearn 2010 participants who are interested in m-learning research projects. No prior experience is required though enthusiasm for m-learning strategies and practice is expected.

Outline of the tutorial content
In this tutorial we investigate student-centered, sustainable no-to-low cost m-learning strategies to enhance learning outcomes. Participants discuss why theories of experiential learning are important to m-learning strategies and practices. We examine how mobile devices and active learning strategies can improve student engagement. Participant's use the no-to-low cost *minteract*™ online tool and discuss the issues that arise. We discuss student-generated vod and screen-casts and improvements in learning. Participants identify their preferred student-centered, sustainable, experiential m-learning strategies and research interests. We start to identify potential research projects and form initial international project teams.

Objectives of the tutorial
By the completion of the tutorial participants will be able to;

1. Appreciate the importance of student-centered m-learning for improving learning outcomes,
2. Understand how sustainable no-to-low cost m-learning can enhance experiential learning,
3. Identify active learning strategies and activities that can use mobile devices to improve student engagement,
4. Use the sustainable no-to-low cost *minteract*™ online tool to improve active engagement in learning spaces,
5. Integrate student-generated vodcasts and screencasts into learning and teaching practice,
6. Identify their preferred student-centered, sustainable, experiential, m-learning research interests,
7. Form initial international m-learning research teams with other tutorial participants,

A detailed description of the tutorial format
1. After introductions we demonstrate, use and discuss the *minteract*™ an online tool that has been developed by the Facilitators to support sustainable experiential learning in lecture-halls and other learning spaces that are connected to the internet. At nil-to-low cost, and more versatile than commercial clickers, the *minteract*™ online tool is a WAP online application that allows students to use their smart-phone, wireless-laptop or other internet-enabled device in the lecture hall to make learning more active, experiential and engaging (Litchfield, Raban, Dyson, Leigh, & Tyler, 2009).

2. We discuss how student-centered and sustainable approaches can improve m-learning strategies and practice (Dyson, Raban, Litchfield, & Lawrence, 2008).

3. Why theories of active learning, and experiential transactions between student and teacher, enhance m-learning strategies and practices (Dyson, Litchfield, Raban, & Tyler, 2009).

4. We identify active learning strategies using mobile devices to sustainably improve student engagement (Dyson, Litchfield, Lawrence, Raban, & Leijdekkers, 2009).

5. We discuss the outstanding learning outcomes achieved in the Facilitator's recent investigations into student-generated vodcasts and screencasts (Litchfield, Dyson, Wright, Pradhan & Courtille, 2010).

6. We discuss researching student-centered, sustainable, experiential m-learning. Participants identify their preferred m-learning research directions (Litchfield, Dyson, Lawrence & Zmijewska, 2007).

7. Participants form initial international m-learning research teams and commence collaboration with other tutorial participants.

Relevant publications

Litchfield, A., Dyson, L.E., Wright, M., Pradhan.S. & Courtille, B. (2010). 'Student-Produced Vodcasts as Active Metacognitive Learning' 10th *IEEE International Conference on Advanced Learning Technologies*, Sousse, Tunesia, 4-7th July,

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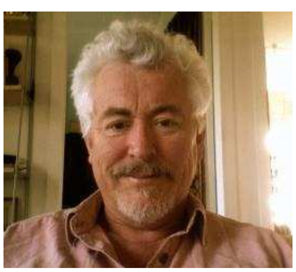
Relevant experience of the facilitators



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Dr Laurel Evelyn Dyson, is a Senior Lecturer in FEIT, and has over 20 years experience teaching in the university and adult education sector where she seeks to create innovative ways of engaging all students in their learning, including with the use of mobile technologies, fieldwork and interactive classroom activities. Her publications include research into mobile and online technology in higher education, collaborative learning and communication, and the adoption of mobile technologies by Indigenous people. Laurel is currently collaborating in the development and evaluation of experiential learning activities for the *mInteract*™ interactive classroom system, and in a project centering on student-generated pod-and-vodcasts about IT careers.

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