mLearn 2008

Conference Proceedings

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From Text to Context

John Traxler

Welcome!

Welcome to all of our speakers, presenters and delegates. This brief introduction to the Proceedings of mLearn2008 is intended to draw together some of the themes and issues emerging from the wide range of papers, presentations and posters at this year's conference in Ironbridge, Shropshire and provide a wider and an historical context for them.

The first in the mLearn conference series, at that time modestly entitled the European Workshop on Mobile and Contextual Learning (http://www.eee.bham.ac.uk/mlearn/), took place in 2002 at Birmingham University. Some seven years later mLearn has returned to Britain, indeed to the Midlands, this time to the UNESCO World Heritage site at Ironbridge in Shropshire with a four-day event with delegates coming from most countries in Europe and from every other continent. Between these, mLearn has visited London, Rome, Cape Town, Banff and Melbourne.

In the intervening period, mobile learning has matured and consolidated (see the reviews by Cobcroft, 2006, and Naismith *et al*, 2004). It now has a newly created peer-reviewed academic journal, the International Journal of Mobile and Blended Learning and a professional body, the International Association for Mobile Learning. It also has a vibrant on-line community, much of it logging onto the Handheld Learning forum (http://www.handheldlearning.co.uk/) and a critical mass of prestigious international conferences such as IADIS Mobile Learning in Europe, IEEE's WMTE workshop in Asia Pacific and our partners for this year, Handheld Learning in Great Britain. Mobile learning has gained clarity about the significant issues (see for example Sharples 2006, defining the 'big issues') and a more sharply defined research agenda (see for example, Arnedillo-Sánchez *et al*, 2007). There have been ongoing efforts in this period to conceptualise and define mobile learning (for example, Wali *et al*, 2008; Traxler, 2008) and relate it to the theorising of 'conventional' e-learning (for example, Laurillard, 2007). There are also some key emerging working texts (Kukulska-Hulme & Traxler, 2005; Metcalf, 2006; JISC, 2005) and some emerging guidelines (see, for example, Vavoula *et al* 2004). These factors taken together might even indicate an incipient 'paradigm shift' (Kuhn, 1970) in learning or a very successful 'diffusion of innovation' (Rogers, 2003)!

Perhaps most importantly however, in this period the mobile learning community has demonstrated that it can:

- Take learning to individuals, communities and countries that were previously too remote, socially or geographically, for other educational initiatives. The *m-learning* project (http://www.m-learning.org/archive/summary.shtml) in Europe, the MoLeNET programme in England and the MobilED project in South Africa (http://mobiled.uiah.fi/?page_id=2) are some of the best examples.
- Enhance and enrich the concept and activity of learning, beyond earlier conceptions of learning. The MOBILearn project in Europe (www.mobilearn.org) was a good example of this achievement.

In the early critical years of the mLearn series, incidentally, both *m-learning* and MobiLearn were key supporters of mLearn.

Interestingly, at the first mLearn in the spring of 2002, a key-note speaker predicted mobile learning would have a separate identity for perhaps five years before blending into general e-learning. This has yet to happen and mobile learning continues to gain identity and definition rather than lose them. There are however still the significant challenges of scale, sustainability, inclusion and equity in all their different forms, and of context and personalisation in all their possibilities, of blending with other established and emerging educational technologies, and of keeping track with the changes in technology itself. There is also the challenge of developing the substantial and credible evidence-base to justify investment in further research and development.

The conference themes and submissions address many of these challenges. The first theme, that of mobile learning, mobile knowledge and mobile societies embraces current ideas about the relationships between discourse, identity and knowledge and ideas about learning with pervasive, ubiquitous and mobile technologies and also covers the social, individual and cultural aspects of mobile learning. This is increasingly significant as societies globally become saturated with mobile devices and technologies. The devices, systems, technology and standards theme looks at technology and devices themselves and at topics of convergence, diversity, frontiers and trends, whilst the mobile learning landscape theme is the focus for innovative projects, programmes and initiatives in work-based, informal, subject-specific and context-aware mobile learning that extend the mobile learning evidence base. Finally, the mobile learning for all theme covering inclusion, assistivity, scalability, embedding, participation, evaluation, evidence, assessment and development explores mobile learning in the context of broader educational priorities.

One specific and obvious topic of the conference, highlighted in the slogan 'from text to context', has been context-aware mobile learning. This has its own, more specific challenges. It may be premature to discuss these in detail but they might include:

- extending the notion of context from the historical emphasis on spatial proximity and profile to social, pedagogic and other aspects of proximity; combining these with pervasive delivery mechanisms; engaging with the Web2.0 philosophy and developing context-aware systems and with 'user-generated content' and the 'learner voice' (two key phrases currently) and
- creating a greater discourse with the communities that commission and design buildings and spaces in order to make context-awareness 'built-in' at the outset rather than 'bolted-on' subsequently
- creating appropriate and effective system development methodologies that capture visions and requirements and evaluate outcomes and achievements
- exploring how experiences of context-aware mobile learning challenge and extend our understanding and theorising of mobile learning (Sharples *et al*, 2007) or perhaps other branches of technology enhanced learning.

A unique innovation at mLearn2008 is the context-aware delegate/visitor support system developed by Dr Chris Dennett and supported by technologies from Edutext and Tribal. In general terms, this is an attempt to 'walk the talk' and combine the medium with the message (McLuhan, 1964). It does however also represent something more significant and specific. A high proportion of the mobile learning innovations at the University of Wolverhampton over the last five or six years have addressed the issues of inclusion, scale and sustainability (for example, the JISC-funded MELaS project), and this conference technology is no exception. Context-aware learning technologies are an established concept and have been used on a relatively small-scale for fixed periods in earlier trials elsewhere (see for example, Lonsdale *et al* 2004). They have however usually been tied to a particular site, venue or location and furthermore have relied on that site, location or venue providing the visitors with dedicated devices, usually just for the duration of their visit. The conference technology is designed to use delegates' (or learners') own mobiles. This means that the concept becomes far more economically attractive and sustainable to museums, galleries and other venues since they no longer bear the burden of buying and maintaining their own specialised devices.

More importantly, however, organisations like the Ironbridge Gorge Trust, with several museums, or a local authority, such as our host authority Telford and Wrekin, with sites distributed across the town, or the National Trust or English Heritage, with properties across the country, can supply information and support informal learning for visitors based on their previous visits, their visits to other museums and on a growing knowledge of their specific interests. This is a major development for delivering personalised informal learning (though not without its ethical dimension). We look forward to hearing your reactions to the system!

We welcome back friends and colleagues from previous mLearn conferences and look forward to meeting those who are new to this series. We trust you will find the next few days interesting, challenging and supportive of your own particular area of research

John Traxler, Conference Chair, Ironbridge

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Learning 21st Century Science in Context with Mobile Technologies

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ABSTRACT
The paper describes a project to support personal inquiry learning with handheld and desktop technology between formal and informal settings. It presents a trial of the technology and learning across a school classroom, sports hall, and library. The main aim of the study was to incorporate inquiry learning activities within an extended school science environment in order to investigate opportunities for technological mediations and to extract initial recommendations for the design of mobile technology to link inquiry learning across different contexts. A critical incident analysis was carried out to identify learning breakdowns and breakthroughs that led to design implications. The main findings are the opportunities that a combination of mobile and fixed technology bring to: manage the formation of groups, display live visualisations of student and teacher data on a shared screen to facilitate motivation and personal relevance, incorporate broader technical support, provide context-specific guidance on the sequence, reasons and aims of learning activities, offer opportunities to micro-sites for reflection and learning in the field, to explicitly support appropriation of data within inquiry and show the relation between specific activities and the general inquiry process.

Author Keywords
Inquiry learning, 21st century science, contextual learning

BACKGROUND

The Personal Inquiry (PI) project is a three-year collaboration between the University of Nottingham and the Open University, UK, to help young people aged 11-14 to understand themselves and their world through a scientific process of active inquiry across formal and informal settings. The children use new methods of Scripted Inquiry Learning, implemented on handheld and classroom computers, to gather and assess evidence, conduct experiments and engage in informed debate. Their activities are based around topic themes – Myself, My Environment, My Community – that engage young learners in investigating their health, diet and fitness, their immediate environment and their wider surroundings. These topics are key elements of the new 21st century science curriculum (Millar & Osborne, 1998) that requires children to reason about the natural sciences as a complex system and to explore how people relate to the physical world.

The technology under development is in the form of an Inquiry Learning Toolkit running on small touch screen computer-phones, with integral cameras and keyboards, plus connected data probes, to enable learners to investigate personally-relevant questions outside the classroom, by gathering and communicating evidence. The Toolkit is designed to support scripted inquiry learning, where scripts are software structures, like dynamic lesson plans, that generate teacher and learner interfaces. These orchestrate the learners through an inquiry learning process providing a sequence of activities, collaborators, software tools and hardware devices, while allowing the teacher to monitor and guide student activity.

The children and their teachers will be able to monitor their learning activity, and to visualize, share, discuss and present the results, through a review tool accessible through a standard web browser running on a desktop or portable computer in the home or school. Teachers will also have a script authoring tool to create and modify the scripts, to support the learning of specific curriculum topics.

The PI project builds on other inquiry projects with mobile devices, such as Savannah (Facer, et al., 2004) and Environmental Detectives (Squire & Klopfer, 2007), but differs in its emphasis on linking formal classroom activities to informal settings such as sports halls and the home.

The paper gives an introduction to current research in inquiry learning and it can be supported by scripted technology. This is followed by the design methodology for the PI project. A case study is then described that incorporates inquiry learning activities into school science classes. The study is described in terms of its science learning content and the technology to support it. A critical incident analysis is presented, as a means to provide design recommendations for the Inquiry Learning Toolkit.

THEORY

Learning by inquiry is a potentially effective strategy when supported appropriately (e.g. Chinn & Malhotra, 2001; White & Frederiksen, 1998) and is an essential tool of the professional scientist. However, de Jong (2006) indicate specific difficulties children have in engaging with inquiry learning, in addition to general metacognitive problems in failing to regulate their behaviour or plan effectively. Based on their findings, children need specific support in:

– designing appropriate experiments (e.g. what variables to chose, how many variables to change, how to state and test hypotheses),

– implementation of experiments (e.g. making predictions, avoiding being fixated with achieving particular results rather than testing hypotheses),

– interpreting results (e.g. children can misinterpret data and representations).

Such support should also be combined with support for argumentation and debate (McAlister et al., 2004).

The approach of 'scripted' collaboration and inquiry has been used in previous research in computer supported collaborative learning (O'Donnell & Dansereau, 1992; Dillenbourg, 2002). Drawing on research in learning design, scaffolding, and guided discovery learning, such scripts are dynamic templates that guide how students should interact and collaborate in addressing a problem. They differ from lesson plans in that they structure and support individual and group learning across different settings. They are implemented as tools and interfaces for technology to support students through a sequence of activities including investigation, debate, inquiry and presentation.

One example of a general script for inquiry-based learning might be:

1. The teacher poses an open question to prompt debate (for example, 'How can I reduce waste?').
2. Students use their handheld devices linked to a classroom data projector to generate initial responses, which the teacher can cluster and display along different dimensions (such as 'importance to me', 'effect on the environment', 'cost').
3. The software selects teams of students whose answers differ along the dimensions and sets them the challenge to move closer in agreement through inquiry and debate.
4. Each team chooses one or more methods of inquiry, such as 'debate with expert' or 'run experiments outdoors'.
5. Software running on their mobile devices provides tailored tools and curriculum materials to structure their investigations as they move between locations, and to transmit the results to a team website.
6. The script-based system guides the students at home and in school to share data, analyse the evidence, and try to reach consensus.
7. Their results, and changes in response to the initial question, are presented and compared in the classroom through a discussion mediated by the teacher.

Other general scripts will support different sequences of inquiry learning activities including: observations; posing questions; examining sources; planning an investigation; data collection; data analysis, visualization and interpretation; resolving differences; proposing answers; presenting and communicating results. Central to the investigation is the question of whether it is possible to identify generic scripts appropriate to inquiry science learning and whether these can be supported through the linking of desktop and mobile technologies. In order to investigate these issues we held pilot trials in a partner school to develop a set of scripted inquiry lessons supported by technology and to describe and analyse critical incidents arising from the trials. Results from the initial school trial are reported in this paper. These are currently informing design of the personal Inquiry Learning Toolkit and the development of scripts to orchestrate science inquiry activities.

METHODOLOGY

We are designing the pedagogy and technology in concert, through an approach to human-centred systems design based on socio-cognitive engineering (Sharples et al., 2002). Like user-centred design, this draws on the knowledge of potential users and other stakeholders and involves them in the design process. But it extends beyond individual users to analyse the activity systems of people and their interaction with technology, building a composite picture of human knowledge and activity that informs the design of the socio-technical systems.

By adopting this design approach, user participation in design decisions becomes critical. Initially this was achieved through focus groups with stakeholders (including teachers, interpretation officers of museums, local authority advisors, qualifications and curriculum authority advisors, business partners and associated academics) to create the learning scenarios, followed by structured interviews that provide requirements for the technology and content design. The next stage is to undertake an initial test of the scripted inquiry learning method, using existing technology. A decision was taken to carry out this trial in a school rather than a research lab so as to test the learning in context. Since the scripted inquiry system had not been implemented, orchestration of the teaching and technology was done by the teacher, assisted by the researchers. This required development, in close cooperation with the teacher, of a detailed lesson plan that could guide not only traditional classroom activities, but also the children's interaction with the technology, inside and outside the classroom. For future trials, orchestration of learning outside the classroom will be progressively managed by software on the children's handheld computers, enabling the children to engage in a structured inquiry process away from the teacher, for example in the school grounds or at home.

METHOD OF THE STUDY

The aim of the school trial was to investigate how children can be helped to engage in a process of scientific inquiry learning across formal and more informal contexts. The formal setting was a science classroom of an inner city secondary school. The less formal setting was the sports hall of a leisure centre which was close to the school. Over a two-week period (5 science lessons), 30 students of Year 9 (age 14) planned a scientific investigation (lesson 1) which they first explored in the relatively controlled environment of the classroom (lesson 2), then extended through a more active engagement with the inquiry process in the leisure centre (lesson 3), and concluded the work in the school library as they analysed the results (lesson 4) and created presentations (lesson 5). All the teaching sessions were videotaped with three cameras: one fixed camera giving an overview of the lesson and two others to record closer views on the classroom or group activity. Radio microphones were used to provide good sound quality. The two cameras recording group activity focused on groups that the teacher had indicated as containing the most and the least able pupils that had given their consent to video capture and analyse their activities.

Science learning

The scientific topic that the research team, in cooperation with the teacher, chose for investigation was the relation between heart rate and fitness. The heart and fitness are topics covered in the UK KeyStage 3 curriculum, fitness is also a topic of personal interest to most children, heart rate can be measured with relatively simple equipment. 'Recovery heart rate' is a measure of how long it takes the heart rate to return to normal (baseline) heart rate after stopping a period of exercise. In general, a fast recovery heart rate is an indication of general fitness and, conversely, people with a slower recovery are at higher risk of sudden death (Cole et al, 1999).

Lesson plans were developed to enable the children to investigate questions about the relation between heart rate and fitness. Five science lessons were planned as shown in Table 1 that took place over a period of two weeks.

Lesson 1	Set up an inquiry question, make predictions	Introduction to the study, familiarisation with scientific enquiry vocabulary and processes, discussion on the inquiry questions to investigate, predictions of possible answers to these inquiry questions. Children are formed into groups of four, with an Exerciser, Note Taker, Photographer, and Computer Handler.
Lesson 2	Carry out an investigation	Introduction to technology. Collection of baseline heart rate in the classroom. In groups, children measure the resting heart rate of the Exerciser. The Notetaker records the results. The Photographer photographs the process. Children elaborate the answer to Question 1. The groups compete over a maze activity and see the effects of excitement and mental activity on their heart rate.
Lesson 3	Carry out an investigation	After walking to the leisure centre, the children in teams collect data for the Resting Heart rate and Recovery Heart Rate of the Exerciser. The Notetaker records the results. The Photographer photographs the process. Children in groups elaborate the answer to Question 2
Lesson 4	Analyse data and conclude findings	In the classroom, the children view, analyse their data and discuss the answer to Question 3.
Lesson 5	Summarise and present the process	The children have access to all their collected data and produce posters to reflect on aspects of the scientific inquiry process

Table 1. Sequence of lessons.

Technology

The technology forms a bridge between contexts, in a similar manner to the MyArtSpace service (Vavoula et al., 2007) but with tighter orchestration of the learning activities. Two sets of technology were developed for the trial: the mobile data collector (which was adapted to project needs by the third author) and visualisation tool and the web-based analysis tool developed by the third author.

The data collection tool comprised a Sunto heart-rate chest strap connected wirelessly to a box that generates a stream of heart-rate data. The box is connected to the USB port on a Samsung Q1 tablet computer running a custom Java program to continuously generate the heart rate as a graph (Figure 1). It also sampled the heart rate every 0.25 seconds to produce a comma-separated stream of data.

Figure 1: An example graph generated from the heart-rate monitor on the tablet computer.

The web-based teaching, running on desktop computers in the classroom, enables each group of students to see the heart rate data collected for the group and by other groups in the class, along with photos taken by the group (Figure 2). It takes the students through a sequence of steps to view and then analyse the data in order to answer Inquiry Questions 2 and 3 (What happens to heart rate with exercise? and What is the relation between heart rate and fitness?).

Figure 2. A screen from the web-based activity showing the recovery time recorded by each group (one group failed to make a measurement), ordered by level of self-reported fitness activity.

Results

The children's science teacher successfully interpreted the lesson plans to guide the children through a sequence of inquiry science activities that connected learning in the classroom and the leisure centre. The lessons were sequenced to first orient the children towards a science inquiry process, and then progressively move from a tightly controlled data collection activity in the classroom, to more self-coordinated groupwork in the leisure centre, and then personal and group reflection and presentation. The teacher reported that time was barely sufficient to complete the first lesson and that the children were somewhat bored in that lesson by the teacher-led work. Once they began to use the heart-rate devices the children were fully engaged with the activity.

The Recovery Heart Rates (RHR) did not show the expected results, in that the children's self-reported levels of fitness did not correlate at all with the RHR: children who reported a high level of weekly fitness activity did not have heart rates that returned more quickly to normal after exercise than those who reported being less generally active. There are many possible reasons for this – including unreliable self reporting of fitness activity, and errors by the children in recording the time taken to recover to base level heart rate – but unexpected results are to be expected from a science inquiry investigation. Interpreting their results and proposing reasons why the data did not match expectations were a learning activity for the children. Nevertheless, the children had enjoyed collecting their own heart rate changes and being able to see and analyse this data in different ways.

In the final lesson, the children produced group posters on each of the three inquiry questions plus a poster on evaluating their experience. The group producing the Evaluation poster were asked to list five things they liked the most and the least during all the lessons. They were also asked to show what they learned about scientific inquiry and how to make things better. What they wrote on the poster is shown below.

Likes: Exercises, Equipment, Different from normal lessons

Dislikes: Disruption [other students disrupting the class]. Wanted more time. Not everyone goes on all equipment.

Things we learnt: Heart rates of different people. How to work as a team. More or less the amount of activities you do the healthier you are. The fitter you are the lower your resting heart rate is. Also the fitter you are the faster your heart rate returns after exercising.

The last is despite their own experiments showing no relation between self-reported level of fitness and measured RHR.

How to make things better: have a whole day working on the subject, have more practicals, more preparation.

CRITICAL INCIDENT ANALYSIS

The main purpose for the evaluation of the initial trials is to provide design recommendations for the next stage of the PI project. More generally, it offers guidelines for the design of mobile technology to link learning between formal and informal contexts such as classrooms and museums, or training centres and workplaces. An evaluation of learning gains is inappropriate for a pilot study intended to explore the effects of introducing a combination of new learning and new technology, so we carried out a critical incident analysis to identify specific learning breakthroughs and breakdowns (Sharples, 1993). Breakthroughs are observable critical incidents which appear to be initiating productive new forms of learning or important conceptual change. Breakdowns are observable critical incidents where a learner is struggling with the technology, is asking for help, or appears to be labouring under a clear misunderstanding. They may either be predictable (e.g. the intervention may be aimed at producing conceptual change) or unpredicted (e.g. a child uses the technology in novel ways, or makes an unforeseen connection or conceptual leap).

The critical incident analysis was conducted as follows. The videotapes were separately viewed by three researchers to identify obvious and informative breakdowns or breakthroughs (for example, where there is some activity and discussion on the video to indicate causes or solutions to the problem, or that suggest the nature of the learning). The identified critical incidents were then compared to reach an agreed set of incidents that might inform design. These are listed here.

Incident 1. Breakdown. (Lesson 1, 18 minutes after start of the lesson) *Allocating children to groups*

Context: Teacher at the front of the class.

Teacher: “I need 6 groups with 4 pupils in, and 2 groups with 3 pupils in. Now go and sit in a group. Take account of people who are away but will be back next lesson.”

This somewhat complicated instruction to form into groups needed to be further modified when the children whose parents had not given permission for them to be videoed needed to be formed into a separate group.

Design implication: Group formation is a complex and contingent process, so simplistic automation may cause more problems than it solves. However, if each child has a personal device, then the teacher could develop or inform a scripting software that allocates children to groups according to specified criteria, including: friendship group, mixed ability, similar ability, or special provision.

Incident 2. Breakdown. (Lesson 1, 42 minutes after start of the lesson) *Participation in groups*

Context: Teacher in the classroom talking to a child in a group of three who have been asked to produce a list of factors that influence heart rate.

Teacher: “Why can’t you add your thoughts to this – because you have plenty of good thoughts – why don’t you put some of your ideas down here?”

Design implication: Zurita et al. (2003) have indicated the opportunity for personal handheld devices to coordinate and synchronise group activity in the classroom, so that the group members all work collaboratively to achieve a shared goal. In this case, it could enable and motivate the children simultaneously to propose factors that they could then combine and discuss.

Incident 3. Breakthrough. (Lesson 2, 17 minutes after the start of the lesson) *Displaying teacher's heart-rate to the class*

Context: The teacher put on a heart-monitoring chest strap that was connected wirelessly to the classroom PC linked to an electronic whiteboard. With this, the teacher could walk round the class while the screen continuously generated a graph of her heart-rate (as in Figure 1).

Teacher: "This is me. … This is beats per minute, so at the moment – look at that, I'm doing quite well. … This [points to a section of the display with a raised heart rate] is where I started to shout, you see. … Do you see what you do to my heart rate? Every time I have to shout.

Design implication: This activity illustrated issues of timeliness and personal relevance in data capture and measurement. Providing a shared display for the teacher, or any of the children, to show and discuss the data as it is being generated can be beneficial. It could provide a means to compare data, show trends, and indicate abnormalities. It can, however, raise social and ethical issues, e.g. showing abnormalities in a person's data. There may also be an opportunity to link large displays already available outside the classroom, for example in a fitness centre or a science museum, to the children's computers.

Incident 4. Breakdown. (Lesson 2, 28 minutes after start of the lesson) *Do we have to draw the graph?*

Context: The teacher has given instructions to the class to draw the graph they are seeing on their tablet computer displays, but one group has lost the image due to battery failure. This technology failure gives the teacher an opportunity to tell students why they need to carry out the particular drawing activity.

Pupil 1: "Miss, do we have to draw the graph, what it says?"

Teacher: "Yes, just sketch it."

Pupil 2: "How can we sketch it, we haven't got it?"

Teacher: "Have you got an idea what it looked like?"

Pupil 3: "At least we know what it looked like."

Pupil 1: "Yes, it's wiggly, like that..<draws it in the air>."

Teacher: "Then it shows you, you know, after we say the Heart Rate is 80 beats per minute which would indicate you'd get a flat line, wouldn't you. But it's not, what it's showing you is that heart rate fluctuates."

Design implication: The computer failure raises technical issues relating to data persistence strategies and policies, design of contingencies and fallbacks and consideration of the broader technical support context (e.g. administration, trouble shooting, charging, and networking). From an educational perspective, students need to be aware of the reasons for carrying out specific learning activities and personal technology could provide context-specific guidance, for those occasions where the teacher is not available.

Incident 5. Breakthrough. (Lesson 2, 42 minutes after start of the lesson) *Do something to increase your heart rate*

Context: A group wants to run a little experiment and see the effects of the heart rate.

Pupil 1: "Do kneels, run on the spot, oh please just run on the spot…Do something, anything to get you heart rate up..

Pupil 2: <pinches the Exerciser> … "Sorry… that took the heart rate up, look!"

Having completed the tasks of the class, this group wants to try something further. Since the Exerciser refuses to carry out an activity himself, one of his group mates tries the effect of pain in heart rate.

Design implication: The system could provide an adaptive ToDo list of extra activities for those students that want to try something further. It could also provide support for students to abstract related information from those activities, through a retrospective 'diary' entry or annotation, e.g. make a note that a specific jump in the graph was when we pinched the person. Such design feature could complement the plan-driven activities with more exploratory inquiry.

Incident 6. Breakdown. (Lesson 3 (sports hall), 11 minutes after start of the lesson) *We're not doing it yet*

Context: The children have arrived in the sports hall and are standing around the fitness equipment. One child gets onto the equipment and starts exercising.

Teacher: "No, we're not doing it yet. We've got to do our resting heart rate. We're doing the resting heart rate first – we don't want to do any exercise for two minutes."

Design implication: The sequencing of some activities is important, while other activities can be conducted in any order. The technology could indicate, e.g. through an adaptive and context-sensitive ToDo list, which activities *must* be done next and which are optional or could be carried out in any order. For sequential activities managed by the system, it could only make the data entry form and equipment available once the previous activity has been fully completed. From an educational perspective, students would need to understand and technology could remind them the reasons for the specific sequencing of activities.

Incident 7. Breakthrough and breakdown. (Lesson 3 (sports hall), 32 minutes after start of the lesson) *Let's have a look at your graph*

Context: The children have collected data on resting heart rate, exercise to target heart rate, and recovery heart rate. The teacher is discussing the results with one group.

Teacher: "Did she get to her target heart rate? Did she get to 145."

Child: "Yeah."

Teacher: "Time taken to get to 145?"

Child 1: "Five minutes."

Teacher: "It wouldn't have taken her five minutes to get to 145 would, it?"

Child 2 (Exerciser): "Miss, it might have, because I was going at my normal walking speed."

Teacher: "Let's have a look at your graph. What have you got. 145 is here. That's 630 seconds."

The teacher calls over the researcher and they have a discussion about the interpretation of the graph generated from the exercise activity.

Teacher: "So she starts her exercise here?"

Researcher: "Probably somewhere about here."

Design implication: The graphs generated in the field can offer 'micro sites' for reflection and learning. In this example, it provides a means for the teacher and children together to validate the child's assertion that it had taken her five minutes to reach the target heart rate. A problem with the current system is that it does not indicate on the graph where the exercise started and ended. This could be solved by having 'start exercise' and 'end exercise' buttons that automatically add labels to the graph, to assist the children in interpreting the data and calculating the results.

Incident 8. Breakthrough. (Lesson 4 (library), 27 minutes after start of the lesson) *Answering the third inquiry question*

Context: A group tries to answer the question and they seek advice from the teacher.

Teacher: "That [group] doesn't have any data [in the chart] because it didn't get any data in lesson 3"

The teacher explains what the chart meant for the particular data point and she further facilitated them in deciding whether there was a trend in their data or not.

Design implication: Students may not be aware of the consequences of not collecting data over the course of an investigation. This indicates the importance of explicitly supporting data appropriation i.e. filtering, selecting and managing the data – within the scientific inquiry process. The technology could also indicate how the data they are collecting fits with the inquiry process as a whole, leading to higher-level understanding. This incident also supports the need for iteration of students' activities across the lessons, which technically might include linking to 'situations like this' or 'this stage' in other experiments or activities done in the past by other students.

Summary of recommendations

The critical incidents have informed recommendations of when and how technology can mediate students' inquiry activities. One recommendation, now being implemented in the Toolkit, is for a 'Dynamic ToDo List' that can display a personal inquiry plan, giving a broad overview of the whole inquiry process that unfolds into a hierarchy of necessary and optional activities. The aim is for students not only to visualise where each activity fits into the inquiry as a whole but also to appreciate how current actions can influence future ones. Another recommendation is for the Toolkit to provide 'micro-sites' for learners to reflect in the field on their actions, for example through simple visualisations of the data collected so far. It can also offer them the possibility to re-visit activities that they missed or ignored and to allow different organising perspectives, through their own, their group's or their class's data. Script authoring software can support the teacher in allocating children to groups according to specified criteria.

CONCLUSION

The Personal Inquiry (PI) project is providing children with new methods of scripted inquiry learning, implemented on handheld and classroom computers, to gather and assess evidence, conduct experiments and engage in informed debate.

Pedagogical activities and technological functionalities are being developed in parallel, through socio-cognitive engineering and participatory design approaches to develop a set of inquiry learning scenarios. These will illustrate how new combinations of technology and pedagogy may be deployed across contexts: connecting learners in and between different locations.

The study described in this paper investigated opportunities for technological mediations and extracted initial recommendations for the design of mobile technology to link learning across different settings. The technology used in the current study consisted of a mobile data-probe and a handheld visualisation tool to collect and reflect on data on a group basis as well as of a web-based tool to support analysis of data as a class. A critical incident analysis was carried out to identify learning breakdowns and breakthroughs that led to design implications. The main implications relate to the need to support group formation, facilitate motivation and personal relevance, incorporate broader technical support, provide reasons for carrying out activities and their sequence, offer micro-sites for learning in the field, and explicitly support appropriation of data within inquiry and link specific activities to the broader picture of the inquiry process. The next stage of the project will develop the Inquiry Learning Toolkit to guide children in personal and group investigations with mobile technology in school grounds, homes and science centres.

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Some Considerations on a Mobile Learning Experience in a Secondary School

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ABSTRACT
In the last few years we have witnessed an increased use of mobile technologies within educational contexts. Mobile learning is characterized as an active, ubiquitous and collaborative learning process, in which the exploration of territory and knowledge construction progress simultaneously. This paper reports on a mobile learning experience we have carried out over the past two years at the Institute for Educational Technologies of Italian National Research Council, with some secondary schools. Firstly we present the theory we investigated as the basis for our work, and then we propose the methodology used. Furthermore, we introduce a data analysis with some considerations about the efficacy and/or efficiency of our m-learning experience.

Author Keywords
Mobile learning, collaborative learning, ubiquitous, mobile technologies

INTRODUCTION

The study of the impact of mobile technologies on learning activities has been widely documented (Tinker, 1997; Soloway et al., 2001; Roschelle, 2003; Klopfer & Squire, 2005; Naismith et al., 2005). Many researchers have investigated the potential of handheld computers for developing new learning practices and transforming interactions between students, study materials and the surrounding world. Furthermore, the availability of cheap and portable GPS devices, embedded or wireless connected with handheld computers, has stimulated new educational experiences in which the location sensitivity of this apparatus can improve learning activities, allowing learners to access supplementary data on the positions of their colleagues and of physical objects of educational interest (De Freita & Levene, 2003). These opportunities open up new learning scenarios (Rosenbaum et al., 2007) based on a mix of social learning theories (constructivism, communities of practice, practice fields, distributed cognition, etc.), learning methodologies (situated learning, computer-supported collaborative learning, lifelong learning, and so on), and hardware devices (smartphones, cell phones, PDA, GPS, wireless technologies, etc.) (Wishart, 2007) . In fact, during the last few years, mobile devices have played a fundamental role in the epistemological evolution of the concept “tool to support cognitive and metacognitive processes” and, nowadays, these new mobile gadgets represent one of the most outstanding challenges in the field of innovative educational methodologies. However, according to Kukulska-Hulme(2007), there is a lack of personal experience of mobile learning on the part of those involved in teaching which creates many barriers to the use of new mobile technologies.

Furthermore, whilst on the one hand the mobile devices represent the technological background behind the activation of innovative educational processes, on the other hand it is extremely important to set up services that can stimulate the collaborative building of knowledge in a community of learners.

The main aim of this paper is to give an account of our efforts to support teachers and students in their mobile learning experience by running the MoULe project. Moreover, we report on a two year period of intensive testing of using some mobile technologies in secondary level education. We want to share our experience in order to address the issues we have observed as well as to present the benefits of mlearning in educational contexts. Often, in an experience of mobile learning it is extremely difficult to evaluate the outcomes since so many factors are involved. We have studied what we consider to be some important aspects of this kind of learning in a mobile experience carried out in four secondary schools in Palermo (Italy).

In the next section we will briefly introduce the tools we provided to the students in their mobile experience. In section three we describe the methodology used in our study. Then, we present some results in order to document the benefits and also the drawbacks we have observed.

BACKGROUND

The mobile learning is a research field in which different theories and methodologies are merging into a new learning framework. Different forces are driving this process: the diffusion of new and cheap mobile devices; the ubiquitous nature of these technologies; the slipping from formal to informal learning practices; the relevant role of constructivism approaches in education. In this context the handheld devices permit to design learning activities in which the students can play a more active role with respect the traditional work in classroom.

Starting from the seminal Ambient Wood project (Sara Price and Yvonne Rogers, 2004) the main aim of the research has been to move “beyond the desktop genre of interaction” towards “digitally augmented physical spaces”. In recent studies, the learning processes has been framed in the context of social networks and Web 2.0 technologies (Axel Burns, 2007); accordingly, collaborative knowledge construction processes become central also during mobile learning experiences (Mike Sharples, 2007; Gunther Kress and Norbert Pachler, 2007).

The augmented reality can be considered as a virtual space where the students can collaborate to create meanings and share chunks of information, gathered during outdoors activities. This virtual space is not limited to a 3D physical space, but it is also a social space, that is a network of participants and technologies, i.e. a fluid space composed by learners, relations and learning resources (Diana Laurillard, 2007; Niall Winters, 2007).

In many projects, researchers have combined outdoors and indoors activities that use ubiquitous computing and mobile technologies together with stationary computers. Amongst the others, the AMULETS project (Kurti, A., 2007) , that since June 2006 has involved more than hundred elementary school children and eighteen teacher students from Växjö University n Sweden. The combination of outdoor and indoor activities through a mix of technologies is central to the MoULe project too. The two projects share further common aspects: both use GPS-enhanced devices for outdoor devices, and several visualization tools, including among others digital maps, are used in the classroom as a tool to organize the knowledge acquired during outdoor learning sessions. The main difference concerns the learning models behind the experience: the AMULETS projects is mainly based on game-based learning strategies, while the MoULe project mainly focuses on collaborative knowledge building paradigms. This difference reflects the end target of the two projects: elementary school children vs. high school students.

The same difference exist between the MoULe project and the POSIT project. POSIT - Developing Public Opinions on Science Using Information Technologies (Teacher Education Program & Department of Urban Studies and Planning - MIT museum & Science, Technology and Society Program) is a project that uses Augmented Reality (AR) and option dynamic games to support discussions around controversies in science and technology. Each player is associated to a virtual character and moves across large outdoor spaces where GPS is used to track player’s position on satellite map.

The MoULe system embraces these ideas and shares some common concepts with other mobile learning projects, like for example:

- MobiMission (coordinated by FutureLab - www.futurelab.org.uk/projects/) a location-based, social, mobile phone experience for young people aged 16-18. The activities are organized in missions, and the learners use the mobile device to reach the target of the mission and to share the outcomes)
- CitiTag (coordinated by Mobile Bristol - http://www.mobilebristol.com/flash.html) a location-based game, designed to enhance social interaction integrating virtual and physical presence.
- MILE project, Mobile & Interactive Learning environment (Kazi, S. A., 2007); the main aim of the MILE project is to introduce mobile devices into an everyday educational setting by creating a learning environment based on constant interaction, collaboration and active participation of students and teachers. The MILE system, as the MoULe environment, is composed of a central component that coordinates students and teachers equipped with mobile devices and specially designed applications that support various educational activities.

A MOBILE AND UBIQUITOUS LEARNING ENVIROMENT

In our testing we have used the MoULe (**Mo**bile and **U**biquitous **Le**arning) system, an online learning environment, designed with the recent web 2.0 technologies. The system we experimented was developed as part of a wider project named CORFAD founded by the Sicilian government, aimed at developing a knowledge centre of distance learning. The MoULe system combines mobile learning activities with well-tested e-leaning functionalities in the same learning environment. We used the MoULe to test an innovative didactic methodology to support student learning activities during on site experiences. One of the main aims of the project was to explore and evaluate ways of using mobile devices to stimulate collaborative learning. The online software environment is accessible both through desktop computers, used by students in the classroom or at home, and through mobile devices during on-site learning activities.

More precisely, the MoULe system is built on the Moodle learning management system (Dougiamas et al., 2003). The MouLE Moodle plugin allows teachers to design a mobile learning activity, defining the Points of Interest (POIs), the learning objectives and the functionalities that students can use during their learning activities. A POI does not indicate a single geo-referenced position, but rather a set of spatial coordinates that represents a geographical area, for example cultural heritage sites or archaeological areas.

In our system the mobile devices offer the same MoULe environment functionalities as the desktops; with the use of GPS technology the system automatically associates the students’ activities and their geographical location.

Two important features of the proposed methodology are:

1. a close relationship between physical objects and the digital objects created during learning activities.
2. collaboration among students to build knowledge in a shared and motivating way.

In particular, students can use mobile tools to tag the physical places that they visit during their learning experiences with textual notes, photos and audio recordings.

The social tagging activities carried out by students during their on site experiences produce an augmented space, that can be used as a basis for collaborative knowledge building through wiki. In this way, the resources produced are always connected to the physical sites associated to POIs.

The system also provides some asynchronous and synchronous communication tools, such as a contextualized search engine that we described in (Arrigo et al, 2007) .

METHODOLOGY

This research focused on investigating the impact of mobile technologies on educational contexts. We established two main objectives: the first focused on testing the didactical features of a mobile learning environment (we used the MoULe system); the second concentrated on the methodological aspects of the project and on evaluating the efficacy of the learning models designed.

The testing methodology was originally designed in two identical cycles involving six high schools in Palermo and each lasting for a four month period. The first took place from February to May 2007 and the second from December 2007 to April 2008. After reviewing the first cycle of testing we decided to modify the original design and make some changes before starting the second cycle. The project funding enabled us to rent only 12 smart phones with GPS aerials and GPRS or EDGE connection. These limited resources were taken into account in our research. Besides, as we will describe below, we changed the connection provider after the first cycle because the service was inefficient and we also reduced the number of students involved.

Moreover, the testing design was also conditioned by certain constraints which prevented us from setting up homogeneous groups using either a randomization procedure or a selection procedure based on the results of pre-tests. In fact, the educational activities were carried out during normal school time and it was not possible to mix the students from the different classes to construct more homogeneous groups. So we allowed the students to form groups spontaneously and observed the interactions between students and recorded data from various sources. We used some tests to assess the initial state of each student and of each class as a unit regarding their social relationships and knowledge about the topics to be studied, and then we observed the spontaneous evolution of the interactions during the didactic experience.

Each testing cycle was designed in two phases: firstly, we tested the prototype with the teachers and then with both students and teachers. In the first phase, after introducing the methodologies and technologies of mobile learning, we encouraged the teachers to design the learning activities and the itinerary for the second phase involving students. Specifically, we asked them to develop a concept map at each school, in order to formally describe the learning paths to be followed by the students. The teachers reacted very favourably to this proposal, especially those with most expertise; in fact, the teachers highlighted the benefits of using concept maps to better specify and clarify the educational objectives to be achieved by students. In addition, they appreciated the opportunity to have practical and tangible results at the end of the design phase, and to share these results with colleagues and students at the starting point for the rest of the activities. We selected the CmapTool (http://cmap.ihmc.us/, developed by the Institute for Human and Machine Cognition http://www.ihmc.us/) to support this process. Finally, the teachers used the MoULe environment, both through desktop computers and smartphones.

While the first phase with the teachers followed a more methodological approach to mobile learning, the second phase was more practical. The students started learning about the main functionalities of the MoULe system and getting used to the mobile devices. Then the teachers explained the outside learning activity they had designed in the first phase which varied according to the type of school. Finally, the students carried out the learning task in the classroom and on site. At the end of the testing phase the students worked collaboratively to produce a hypermedia artifact about the sites they had visited.

Details of the first cycle

The first cycle was held in spring 2007, and fifteen teachers of different subjects from five secondary schools in Palermo followed the first phase as described above.

Then, in the second phase, we involved eighty students and twelve teachers from two secondary schools, one specializing in pedagogical subjects and the other in tourism. Two fourth year classes were selected from each school. The students from the pedagogical school followed a “historical street markets” itinerary, while the students from the tourism school followed a “baroque age” itinerary. The testing was organized as follows: first, for each school we arranged a plenary meeting with the two classes, then each class participated in four testing sessions, two of them carried out in the classroom and two on site. A final plenary meeting was held after the testing sessions. The aim of the preliminary meeting was to explain the project guidelines and the MoULe functionalities to the students. We asked the students to fill in two questionnaires. The first was to find out about the technical background of the students, while the second was a sociometric test to investigate the relationships between the students in each class, in order to create workgroups for the testing stage. Next, each class was asked to take part in four test sessions, two in the laboratory and two on site. The class in the laboratory used desktop computers connected to the Internet, while the other class went on site and used handheld devices with wireless connections. In alternating sessions the roles of the two classes were inverted. These sessions were held on different days for each school both for organizational and logistic reasons, and because the schools followed different itineraries. In particular, the school specializing in pedagogical subjects, alternated a study of the anthropological aspects of Palermo's street markets with a survey of their neighbourhoods with particular analysis of the relationships between people and their environment. Instead, the school specializing in tourism had a different objective for each session. First, they studied the external aspects of some examples of Baroque architecture in their context, then they analyzed the internal features of the same buildings. In the third session, they focused on the tourist services in the same areas (such as hotels, bars, restaurants), and finally in the last session, they gathered information about other interesting points of interest near the area they visited.

On site activities

In the on site experience we provided students with smartphones with GPS aerials, used to localize the activities performed by the students. In particular, we used two different hardware models in order to evaluate the system functionality independently of the resources employed. The Internet connection was provided by a national provider using GPRS technology. Students were divided into pairs and each pair member used the PDA alternately to perform learning activities on site. A teacher and/or a CNR researcher accompanied each pair of students.

The on site sessions took place as follows:

1. Students, teachers and CNR researchers met at an arranged meeting-point in the historical area of the city.
2. Students were divided into pairs or small groups and teachers assigned the tasks to perform on the itinerary.
3. Students visited the points of interest (POIs) according to their learning path. They used the MoULe system to locate the POIs, to communicate with the students from the other class who were testing the prototype in the school laboratory, to take multimedia notes and to edit learning contents.
4. Students returned to the initial meeting-point.

In the classroom laboratory

While one class was on site, the students from the other class accessed the MoULe system through the desktop computers in the school laboratory. In this way the two classes participated in the same virtual environment. The students on site cooperated with the students in the laboratory sharing information, asking each other questions and working collaboratively in order to create learning contents as defined by the teachers. In particular, students with desktop computers connected to the MoULe through the Moodle Learning Management System, and they used the following tools:

- communication tools to request extra information (through multimedia notes) from the students on site, or to provide specific information to the students on site;
- a specialized search engine to search for learning material specifically filtered according to the point of interest;
- a wiki style collaborative document creation tool, to create the learning hypermedia of the learning path;
- a visualization tool to show the geographical positions of the students in order to coordinate their on site activities.

All the test activities on site and in the laboratory were supported and supervised by teachers and CNR researchers.

At the end of the test sessions we organized a final meeting to present the test results and students were asked to fill in two questionnaires, one to evaluate the learning experience and the other was again a sociometric test to evaluate the effects of the MoULe system on the social relationships between the students.

In this first cycle, the students produced two hypermedia depending on their school. One was a tourist guide to Baroque in Palermo in Italian, English and French and the other was about the street markets in Palermo. Both are available, with authorized access, at http://moule.pa.itd.cnr.it.

Details of the second cycle

At the end of the first testing cycle we collected a large amount of data concerning the students' mobile learning experiences. In fact, the MoULe system logs all user interactions. We also tracked the geographical location related to the activities (e.g the student's position when he sent a chat message or recorded an interview).

The analysis of these data gave us important feedback for the second testing cycle. We took into consideration the technological limitations and constraints which had conditioned our testing. First of all, the small number of mobile devices available; the first cycle involved 80 students and they had to share a smartphone so we had some problems associating input to an individual student and following the individual learning paths. In fact, we could not discriminate between the contributions made by the members of each pair because they worked together. Then, we corrected all the bugs reported and we made some changes to some parts of the program interface to improve the usability. Another important issue we had in the first cycle was connected to the inefficiency (concerning the services as well as the GPRS technology) of the mobile provider used.

Thus, taking into account these considerations and the technological corrections, in winter 2007 we carried out the second testing cycle. This involved new actors (students and teachers). In particular, we tested the mobile learning with 14 teachers from 3 secondary schools in the first phase and with only 34 students in the second phase. We involved less than half the number of students with respect to the first cycle to address some of the issues observed in the previous experience. The students were also from two secondary schools, but this time one school specialized in economics and the other in tourism. This time only one fourth year class was selected from each school. We divided the class in half in order to create two groups. The two groups worked in the same way as the two classes in the first cycle. Thus, they alternated between on site and classroom laboratory activities. This time each student working on site had a smartphone so we could observe his/her learning path more clearly.

Otherwise the second cycle was exactly the same as the first.

RESULTS AND DISCUSSION

As described in the methodology presented above we used some tools to assess the starting point of each student and of each class as a unit, and then we observed the spontaneous evolution of the interactions during the didactic experience. This approach can make it difficult to highlight the most important factors influencing the experimental results, but we think it is the most effective procedure for capturing real social interaction "in vivo". We designed some tools to assess the evolution of this experience over time; these are summarised in the following table 1.

At the beginning we administered the following questionnaires
Sociometric
Technological competencies
Knowledge of the geographical area
Knowledge of the topics
During the experience we gathered data on
Types and numbers of information items
Geographical location of resources and students
Time evolution of the didactic experience
Observation card
At the end we administered the following questionnaires
Sociometric
Degree of involvement and enthusiasm
Degree of interest and agreement
Description of experience

Table 2. Assessment Tools

In fact, according to Riva and Sudweeks-Simoff (1999) the data analysis have followed a complementary approach, thus integrating both qualitative and quantitative tools. Moreover, the choice of these tools and the types of data reflect our intention to find answers to one of the main question that we consider important for evaluating an experience of mobile learning: “has the use of mobile devices and the planned educational experience affected the knowledge building process interactions both for the single student and for the classes?” This question is not simple to answer; in this paper we attempt to address these issues focussing our attention on these following points:

1. how the students have used the various collaborative tools available in the MoULe environment;
2. how many multimedia notes were used to build the final hypermedia;
3. how many notes each students have used himself to improve the knowledge?
4. whether a collaborative environment has been established during these experiences;

In the following part of this paper we discuss these points using only a few of the data described in Table 1. In particular, we analyse the information gathered during the experience and recorded in the log files. In fact, the MoULe system tracks all user interaction and registers also the geographical location related to each activity. Thus, in the next subsection we discuss some quantitative data concerning the testing, then we report some results on the knowledge building process. However, since the analysis of the second cycle testing data is not yet complete, in this paper we report the data of the first testing cycle and provide only some preliminary results about the second one.

Results about the tool usage in our mobile experience

In Table 2 we present some descriptive data regarding the results of the experience in the schools involved in our first cycle testing. These data do not show any relevant differences, even though the students at school 2 appear to have worked more intensively on the wiki activity, considering the number of pages edited and the percentage of students that used this tool. The mobile notes were used extensively in both schools, and an average of 13/14 notes were made by each student. Regarding the use of the forum tool, at school 1 we observed the most relevant number of messages but the activity was carried out by the 63% of the students, while at school 2 the activity appears less intensive but more widely used (80% of students). These data and the behaviours observed during the experience show that students made great use of the tools available, with a preference for mobile notes; the mobile notes was used to enrich the wiki pages, adding images and audio, developing a collaborative environment where the users in the laboratory used the chat tool to request new information in order to enrich the wiki pages.

School 1			**School 2**		
Topic: Tourist guide to the monuments of the baroque age			**Topic**: Historical street markets of Palermo		
no. of students	total	41	no. of students	Total	39
	class A	23		class A	17
	class B	18		class B	22
Wiki usage			**Wiki usage**		
no. of users	22	54% of total	no. of users	29	74% of total
no. of wiki pages edited	total	23	no. of wiki pages edited	Total	62
	per user	1.04 pages/user		per user	2.14 pages/user
no. of accesses to wiki	total	2029	no. of accesses to wiki	Total	1994
	per user	92 accesses/user		per user	69 accesses/user
Notes usage			**Notes usage**		
no. of users	34	83% of total	no. of users	34	87% of total
no. of notes created	total	483	no. of notes created	Total	445
	per user	14 notes/user		per user	13 notess/user
Percentage of total area covered by tags		59%	Percentage of total area covered by tags		62%
Forum usage			**Forum usage**		
no. of users	26	63% of total	no. of users	31	80% of total
no. of messages	total	136	no. of messages	Total	93
	per user	5,23 mess./user		per user	3.00 mess./user

Table 3. Descriptive results of the experience in the two schools

A preliminary analysis of the tool usage for the second testing cycle, shows some differences regarding the amount of data the students gathered and the number of messages and interactions. These differences, which are still to be confirmed, are probably due in part to system bug fixing and the more efficient wireless service provider used in the second cycle.

The knowledge building process

In order to evaluate the impact of our mobile solution on the learning activities, in table 3 we present some data regarding the learning material that the students produced. In particular, we report the number of wiki pages collaboratively produced and some data on how many notes they used in their artefacts.

These data show some differences between the two cycles. In the first cycle the students produced more pages but they used fewer notes. However, they used the note tools more for collaborating than for directly enriching the final hypermedia. For example, in most cases they used the notes in order to make suggestions to each other about the contents of some wiki pages.

Cycle	itinerary	Pages created	Used notes	Note per page
1	Historical street market	122	81	0,66
	Baroque age	94	36	0,38
2	The historic villas in the “Piana dei Colli”	23	27	1,17
	Commerce in the Zisa-Noce area	36	85	2,36

Table 3. Table captions should be centred below tables.

In the second cycle, although the students seem to have created fewer pages, they have used almost the same number of notes in their wiki pages. We can see they have included between 1.17 and 2.36 notes per page. Furthermore, the small number of pages created, with respect to the first cycle, is not so relevant because the students preferred to build fewer pages but fill them with multimedia contents. Thus, these data show that the information gathered onsite was the same overall in both cycles.

We would also like to highlight some differences related to the itinerary which do not depend on the changes we made before starting the second cycle. Apart from the number of wiki pages it is apparent that in some itineraries the number of notes used to build the final artefact are significantly different. These anomalies are often correlated to the class activity coordination. We observed that in the classes where the teachers were more involved in coordinating learning activities the results of note usage were better. In particular, some differences can be seen between the educational itineraries: the students at two schools where we have a higher note usage were involved in a more highly structured experience. In this case, the teachers prepared some documents to guide the students' on site activity, and the wiki site reflects this structure. Instead, the activities of the students from the other two schools were more open in their structure and the process of knowledge building reveals a fuller collaboration between the students.

Nevertheless, these differences do not show that some classes were more efficient in terms of learning than others. Rather, these results suggest only that the students were probably more stimulated/influenced by using the contextually appropriate technology we provided.

CONCLUSIONS

In this paper we have presented our research to support teachers and students in their mobile learning experience by running the MoULe project. We have shared our experience in order to address the issues we observed in a two-year period of intensive testing of using mobile technologies in secondary level education.

According to the results of two-cycle testing, we think that it is extremely difficult to evaluate the outcomes of an mobile learning experience, due to the great number of variables to be controlled. In the paper we have highlighted what we consider to be some important aspects of this kind of learning in a mobile experience carried out in four secondary schools in Palermo (Italy). We have observed a general improvement in the student knowledge and in students and teachers motivation in using the technologies. Furthermore, the students used the mobile tools intensively and experienced a new way of learning. Moreover, in our experience we observed that motivational factors can also play a part in the success of a mobile learning experience. This aspect is generally considered from the students' point of view but we have noticed that it influences the teachers' involvement and the results of the work. Some of the motivational factors are similar for teachers and students, such as a desire to exercise control over learning aims, a feeling of ownership of the materials produced, a sense of enjoyment, and the chance to develop more meaningful dialogue within the class. Other factors are more typical of teachers, such as the wish to set learning activities in an every day context and to make students feel part of a wider social environment, as well as the chance to improve their skills in using technological tools.

The two-cycle testing gave us the opportunity to fix some technical issues. In addition, we reduced, from the first cycle to the second, the number of students involved in the project to better focus on the contribution provided by each student. However, taking into account the results of both testing cycles, we can state that although we had serious technical problems (mainly network connections but also some system bugs) we reached the conclusion that the first cycle testing was not influenced by these technical issues because the data trend in both cycles is the same.

Finally, we are still analysing the second cycle testing data although the preliminary results suggest important benefits on using the mobile technologies in onsite learning.

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Towards Sustainable Large Scale Implementation of Mobile Learning: the Mobile Learning Network (MoLeNET)

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ABSTRACT

MoLeNET is a unique collaborative approach to enabling and supporting large scale implementation of mobile learning primarily in the English Further Education (FE) sector but involving other education and training partners including schools. This paper describes the challenges facing MoLeNET, the organisations funding and supporting the participating institutions and how some of these are being addressed. Particular challenges include achieving implementations of mobile learning which have a significant positive impact upon the institutions, teachers and learners involved and maximising the likelihood of organisational and practice change which continues beyond the availability of external funding.

BACKGROUND

In 2007 Professor Mike Sharples observed "over the past ten years mobile learning has grown from a minor research interest to a set of significant projects in schools, workplaces, museums, cities and rural areas around the world." (Sharples, M, 2007)[i]. Tony Burgess, at that time Senior e-Learning Policy Adviser at the Learning and Skills Council (LSC), had also noted the progress made in mobile learning since the LSC had lent its support to the first big European mobile learning research and development programme, m-learning (2001-2004), led by the Learning and Skills Agency (LSDA). The findings of the m-learning programme had indicated that mobile learning had great potential especially for hard-to-reach young people with literacy and numeracy difficulties (Attewell, J, 2005[ii]). He concluded that the time was right to move beyond small scale research and development by enabling a large implementation of mobile learning in the English Further Education (FE) sector. This implementation was to be facilitated by the provision of £6million of capital funding in 2007/08 and the implementation was to be managed and supported by the Learning and Skills Network (LSN), one of the two organisations which evolved from LSDA, via the Mobile Learning Network (MoLeNET) programme.

THE CHALLENGES

THE OVERARCHING OBJECTIVE OF MOLENET WAS TO INTRODUCE MOBILE LEARNING IN A WAY WHICH WOULD MAXIMISE THE LIKELIHOOD OF IT BECOMING EMBEDDED INTO PRACTICE AND THEREFORE CONTINUE TO HAVE A POSITIVE IMPACT ON TEACHING, LEARNING AND THE LEARNER EXPERIENCE.

The funding available from LSC was ring fenced for spending on capital equipment and evidence from previous initiatives over many years indicated that it is very difficult to achieve on-going change with one-off capital funding as there is a tendency for initiatives to die when external funding runs out. Therefore it was necessary to develop sustainability strategies to maximise the likelihood of any introduction of mobile learning continuing beyond the initial funded phase.

THE CAPITAL FUNDING PROVIDED BY LSC HAD TO BE SPENT WITHIN THE FINANCIAL YEAR WITH EVIDENCE OF IMPACT GENERATED WITHIN THE ACADEMIC YEAR. CLEARLY THE TIME AVAILABLE IN THE 2007/08 ACADEMIC YEAR OFFERED LIMITED SCOPE FOR ENSURING AND VERIFYING THAT MOBILE LEARNING HAD BEEN ADOPTED IN A MANNER WHICH WAS MAKING A SIGNIFICANT CONTRIBUTION TO THE QUALITY OF TEACHING AND LEARNING IN THE INSTITUTIONS INVOLVED.

UNTIL 2007 IN THE EDUCATION SECTOR MOST MOBILE LEARNING HAD CONSISTED OF SMALL PROJECTS OR SHORT TERM EXPERIMENTS. WHILST IN THE COMMERCIAL SECTOR LARGER IMPLEMENTATIONS TENDED TO CONSIST MOSTLY OF PROVIDING ACCESS TO REFERENCE MATERIAL OR LECTURES.

For example IBM enabling downloading short "chunks" of their "web lectures" to mobile devices thus allowing employees to "learn on the go instead of being restricted to an office or conference" (Von Koschembarh, C and Sagrott, S in Kukulska-Hulme, A and Traxler, J, 2005iii).

THIS APPROACH, WHILST VERY USEFUL FOR THE COMPANY AND ITS EMPLOYEES, COULD BE USED AS AN EXEMPLAR OF ONLY ONE OF MANY POTENTIAL APPLICATIONS OF MOBILE LEARNING IN FURTHER EDUCATION.

FOR MOST STAFF AND MANAGERS WORKING IN EDUCATION THE CONCEPT AND PRACTICE OF MOBILE LEARNING WERE STILL EITHER UNKNOWN OR VERY NEW. THE NEWNESS OF THE PRACTICE OF MOBILE LEARNING ALSO MEANT THAT THERE WAS A SHORTAGE OF SUITABLY SKILLED AND EXPERIENCED PRACTITIONERS AVAILABLE TO SUPPORT INSTITUTIONS INTRODUCING MOBILE LEARNING FOR THE FIRST TIME.

ADDRESSING THE CHALLENGES

Capital only funding and sustainability

In seeking to address the challenge of available funding being ring fenced for capital expenditure LSC and LSN perceived an opportunity to make a virtue of a necessity. A new funding model was developed which would require institutions participating in MoLeNET to make a financial contribution to the funding of support and evaluation as a condition of receiving capital funds. This was intended to deliver the dual benefits of both making available funds for support and evaluation and ensuring that participating institutions' senior management would be committed to ensuring successful and sustained implementation of mobile learning. The funding model (illustrated in figure 1) also recognised that participating institutions would need to make significant in-kind contributions to ensure successful implementation and embedding.

Capital funding (LSC) Mobile technologies and infrastructure e.g. servers and wireless networking	**Staff time & costs (Project Partners)** Staff time, travel, subsistence, cover, institutional overheads
Support & Mentoring (LSN funded by projects contributions)	
Research & Evaluation (LSN funded by projects contributions)	

Figure 1: MoLeNET Funding Model

In their final reports MoLeNET Project Managers were asked whether contributing cash to the programme had resulted in greater senior management team interest in their project's outcomes and whether it had resulted in greater senior management involvement in the project. As illustrated by the graphs in figures 2 and 3, a large number of Project Managers indicated that they believed the shared cost funding model had had these effects.

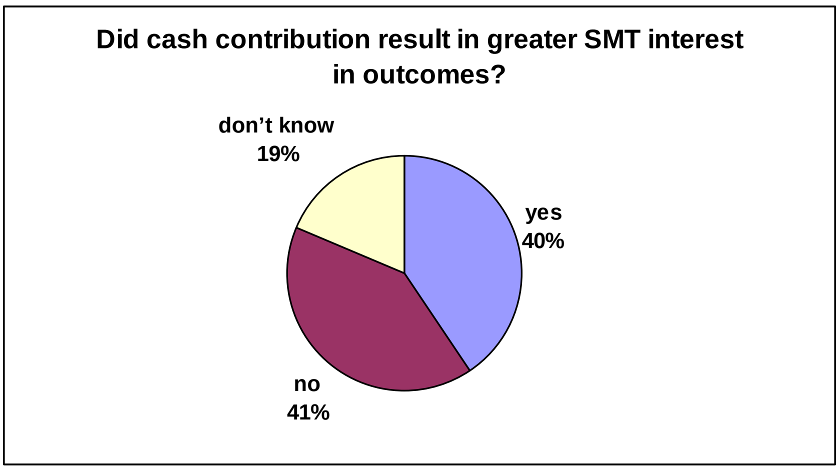

Figure 2

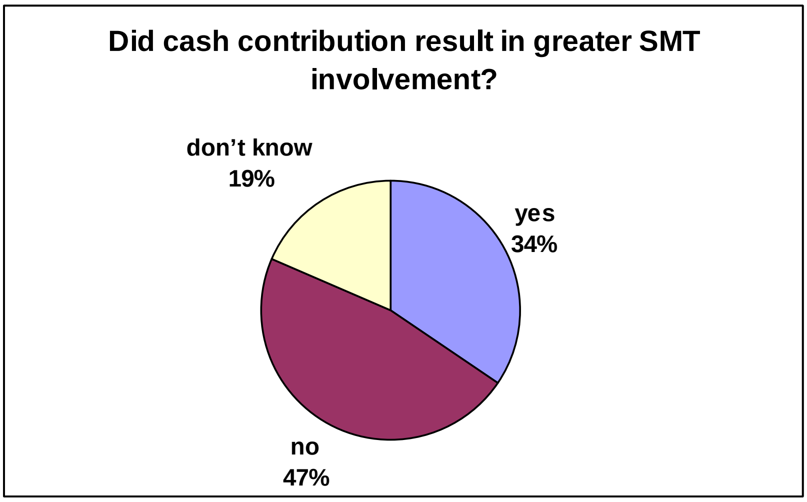

Figure 3

Some Project Managers qualified their responses by adding such comments as "The college executive was fully engaged with the project regardless of the contribution." (Coulsdon College) and "Making a contribution towards the support programme did not significantly affect the approach of the college towards the project as Lewisham College has always been committed to exploring innovative use of technology to improve the learner experience". Whilst other Project Mangers added comments supporting their belief that the contribution did have a positive effect on SMT engagement e.g. "The commitment shown by an organisation by providing the 20% …is a very positive one. Ultimately, this commitment has to come from SMT and therefore with this comes the guarantee that each organisation is truly supported to achieve its stated outcomes" (Bolton College) and "The funding contribution helped ensure a good level of SMT interest in the 'dark' days before the project benefits started to materialise." (Regent College)

One aspect of research by LSN during both the 2007/08 and 2008/09 academic years is focussing on the extent to which mobile learning is being (a) expanded within institutions (including FE colleges and some schools) taking part in MoLeNET and (b) transforming the institution. The findings of this research help to ascertain whether MoLeNET funding has had, or is likely to achieve, impact beyond the period for which external funding is provided.

The research instrument used is hosted on the MoLeNET project reporting moodle course and can be completed very quickly and easily. Key contacts for each of the participating institutions were asked to consider 4 areas, to self assess the status of their institution in each of these areas and to indicate for each which of 5 statements most accurately describe the situation at their institution (see figure 4). Answers were collected for the situation pertaining before the start of MoLeNET i.e. September 2007 with the same questions being posed in April 2008, July 2008, September 2008, April 2009 and July 2009 in order to gauge the distance travelled during and following involvement in MoLeNET. Respondents are also asked to indicate whether their institutions had any previous experience of mobile learning prior to taking part in MoLeNET. For each of the 4 questions the 5 statements range from indicating little or no interest or involvement in mobile learning through to describing mobile learning having become embedded and/or achieving transformation.

The development of this research instrument was informed by the MIT90s framework particularly Venkatraman's 5 levels of business transformation achieved through the use of IT (Venkatraman, N. and Henderson, J. C., 1993[iv]), which has also informed e-learning benchmarking work by UK education sector agencies i.e. JISC and Becta.

Senior Management

1. SMT are not interested in mobile learning
2. SMT are interested in mobile learning (e.g. exploring funding opportunities)
3. SMT are actively supporting and engaging with initial implementation of mobile learning (e.g. via a MoLeNET project)
4. SMT have a strategy for extending mobile learning to more departments in the future

5. SMT have a strategy embedding mobile learning into delivery across the institution

Teaching staff

1. No teaching staff are involved in mobile learning
2. Some teaching staff are involved in mobile learning (e.g. via a MoLeNET project)
3. All teaching staff are being encouraged to think about how they could apply mobile learning and/or are being offered mobile learning CPD
4. Some teaching staff are embedding mobile learning into their delivery
5. Most teaching staff are embedding mobile learning into their delivery

IT department

1. IT staff do not support the introduction of mobile learning (e.g. due to concerns that the introduction of mobile learning could compromise security)
2. IT staff are providing some support for the introduction of mobile learning (e.g. some support for a MoLeNET project)
3. IT staff are actively involved in selection of technologies and/or implementation of infrastructure to enable introduction of mobile learning (e.g. a MoLeNET project)
4. IT staff are an integral part of a mobile learning/MoLeNET project team and are committed to helping to ensure the success of the project
5. IT department has a strategy for supporting extending and embedding the use of mobile learning across the institution

Mobile learning in your institution

1. Mobile learning is not used in any departments
2. Some small scale implementation/piloting of mobile learning is taking place
3. Several departments are using mobile learning
4. Most departments are using mobile learning
5. Mobile learning is embedded into the culture of the institution supported by CPD and strategies for sustainability

Figure 4: MoLeNET mobile learning transformation questions

At time of writing the results of the m-maturity surveys have not been fully analysed. However interim results do indicate progress between the first and second surveys as illustrated in figures 5 to 8.

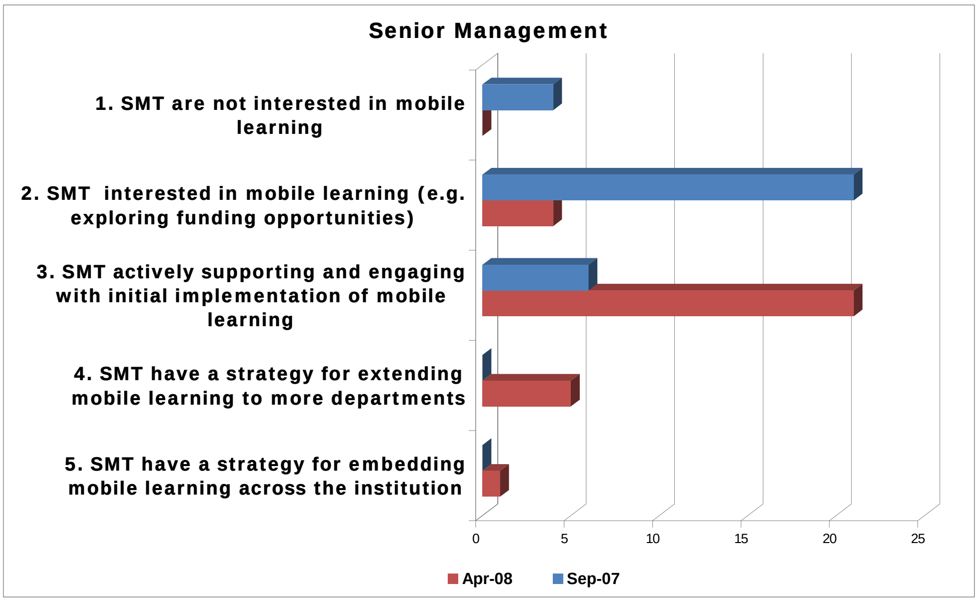

Figure 5

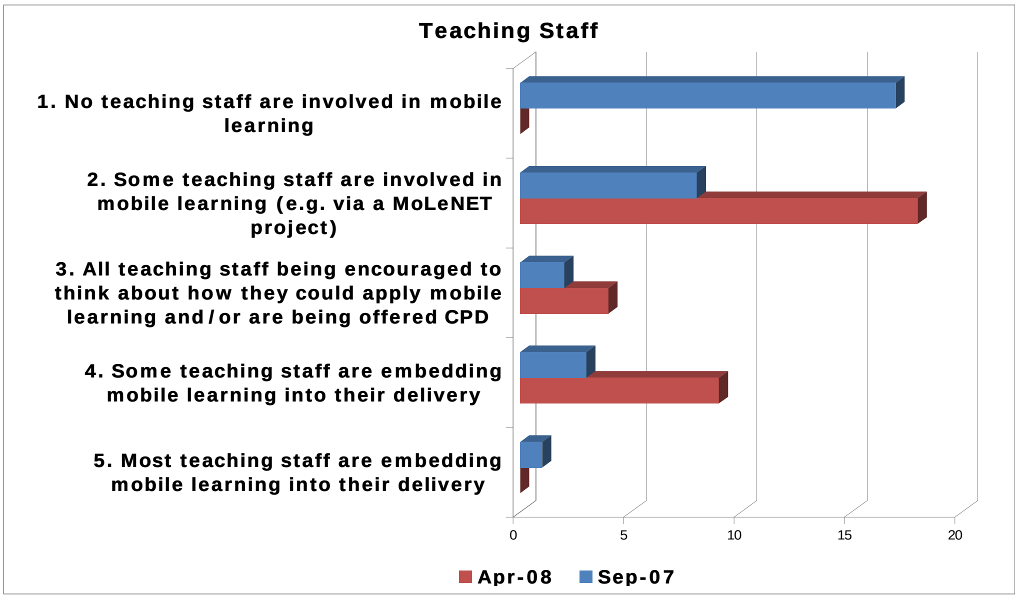

Figure 6

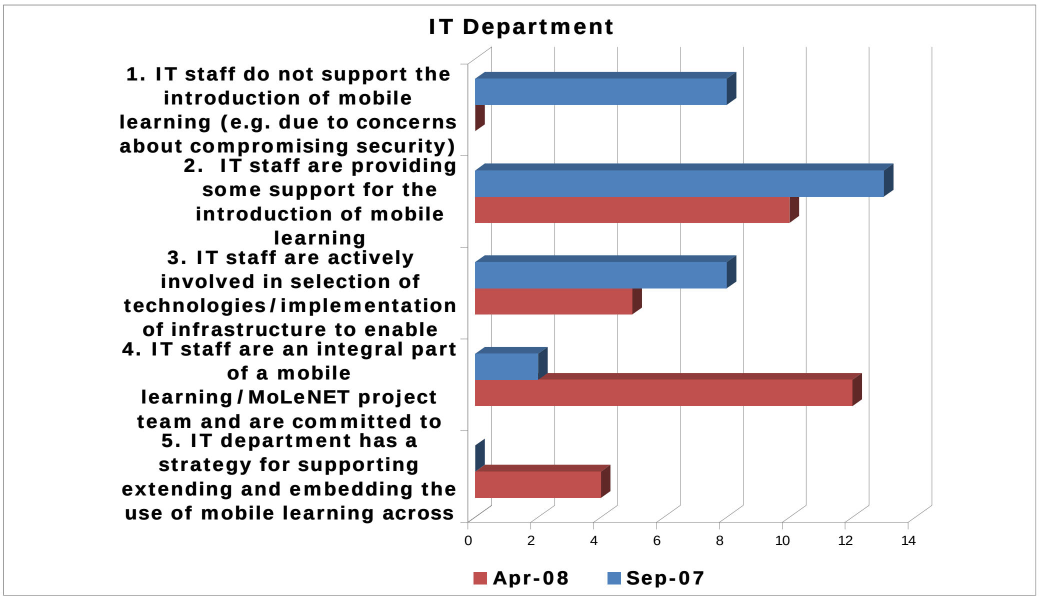

Figure 7

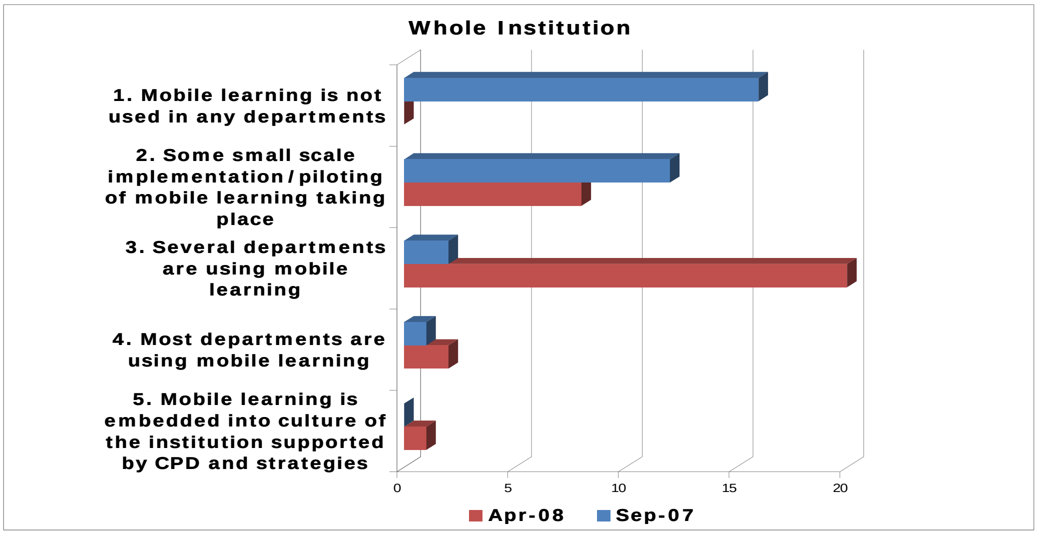

Figure 8

The four graphs in figures 5 to 8 all show progress and analysis of the data in SPSS using paired t-test analysis indicates that there is a highly significant, positive difference between the institutions' situation before MoLeNET and their situations half way through the year during which MoLeNET projects started in all four areas i.e. Senior Management, Teachers and IT Department attitudes and actions plus whole institution situation.

One of the risks identified at the beginning of the MoLeNET initiative was that colleges might be unwilling to commit their own funds to shared cost projects.

During the set up phase of the initiative an Expression of Interest process and an Information Day were used to gauge the level of interest, to assess whether there would be a problem persuading colleges to take part in view of the funding model and to answer all queries and concerns raised. The reaction of the FE sector at this stage was very positive at this stage, exemplified by over 200 people attending the Information Day, and the response to the Invitation to tender (ITT) was even more so. A budget of over £19 million would have been required to provide the capital funding requested by all 81 shared cost projects proposed in response to the ITT.

Following selection and start up of the successful projects, a survey of those colleges which did not submit a bid in response to the ITT was carried out. A key aim of the survey was to discover if the funding model had been a significant factor in discouraging participation in MoLeNET. 83 responses were received and the most common reasons given for not participating are illustrated in figure 9. Whilst many respondents indicate that the funding model was a problem the majority did not cite the funding contribution as a reason for not bidding. Significant numbers of respondents selected reasons for not bidding which indicate concerns about the limited amount of time available to write bids and pressure of work making it difficult for staff to participate either in bid writing or delivering the project if the bid was successful. When asked whether they might propose a MoLeNET project in response to a similar ITT in future, more than a third of respondents (36%) said this is "likely" or "very likely" and 37% replied that it is "possible" that they would bid.

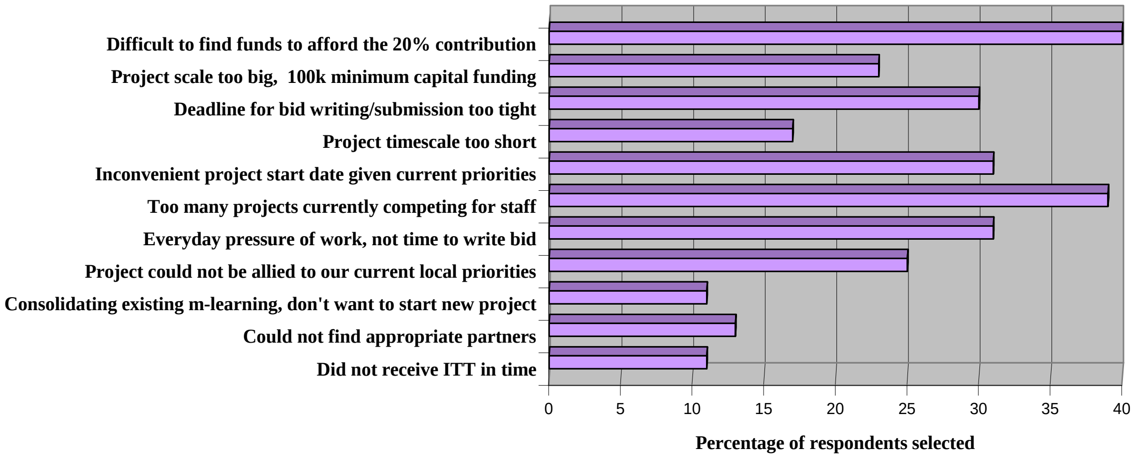

Figure 9: FE college reasons for not responding to MoLeNET

Collaboration and peer to peer support

Limited availability of mobile learning expertise and experience is an issue both within institutions and throughout the education sector. Therefore collaboration, mentoring and peer-to-peer support are key characteristics of the Continuing Professional Development (CPD) and Support Strand of the MoLeNET Support and Evaluation Programme (illustrated in Figure 10).

Figure 10: MoLeNET CPD and Support

Collaboration takes place at several levels, i.e:

At national level

- LSC and colleges jointly fund the introduction of mobile learning technologies
- LSN collaborate with mobile technology and mobile learning experts to provide technical training, continuing professional development for teaching staff, support, mentoring and knowledge sharing and an expert Advisory board provides advice and guidance to LSN

At local level and regional level

- Colleges are encouraged to collaborate with each other and with other education and training providers within consortia and with other projects to achieve economies of scale
- MoLeNET project managers and other participants are provided with an on-line environment which enables peer-to-peer support, knowledge sharing and sharing of resources and learning materials, as well as virtual and on-site support from a named mentor.
- Within projects teaching staff, e-learning experts, IT staff and management are encouraged to collaborate to ensure the success of mobile learning.
- Regionally collaboration with JISC RSCs includes some RSC support for CPD events in their areas and free places on MoLeNET events for RSCs staff to help mobile learning expertise capacity building
- LSN researchers collaborate with practitioner researchers in participating institutions in gathering and assessing evidence of the impact of mobile learning on teaching and learning and the effectiveness of the MoLeNET programme.

The CPD and Support strand aims to provide the best possible support for MoLeNET projects within the constraints of time and budget whilst helping to achieve the overall Support and Evaluation programme aims which are:

- to ensure distribution of capital funding in an equitable and efficient manner that will maximise benefit to the sector
- to support colleges in the introduction of mobile learning, both within the programme and in preparation for further mobile learning beyond the life of the programme
- to seek evidence that the introduction of mobile learning can have a significant positive impact on teaching and learning

CONCLUSION

The presentation at MLEARN 2008 will include detailed findings of the MoLeNET research and evaluation related to achieving sustainable large scale implementation of mobile learning and how the lessons learned are being used to continue to expand mobile learning.

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A Bridge too far? – Embedding Mobile Learning in UK Higher Education

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ABSTRACT

Wireless-based technologies have the potential to radically impact the way courses are delivered to students in Higher Education through the innovation of 'm-Learning'. M-Learning has the power to be highly disruptive to the way in which university courses are delivered and raises fundamental questions about how people teach and learn and the culture and structure of the educational institute itself. The paper looks at mobile learning from an innovation diffusion perspective. Based on interviews at ten UK universities, it reveals sources of conflict with existing university business models and established structures and practice. It proposes a series of case studies on live mobile learning projects to develop this work further using actor network theory to interpret the findings and establish what will make m-learning translate irreversibly into university environments.

Keywords

Innovation, Mobile learning, actor network theory, higher education

INTRODUCTION

Within the growing body of literature on m-learning, it is the teaching and learning aspects rather than the business issues surrounding the introduction of m-learning that have so far received most attention (Sharples et. al, 2007; Kukulska-Hulme, 2007). Traxler has provided some pointers to potential problems that educational institutions might face, such as changing the nature of work and altering work-life balance. He has also noted that the technology is likely to be alien to IT support staff experienced in supporting fixed PCs with fairly long operating lives (Kukulska-Hulme and Traxler, 2005). Sharples has highlighted the potential for mobile devices to disrupt the carefully managed environment of the classroom (Sharples, 2002), but there is scope for deeper understanding. This paper seeks to interpret mobile learning as a technology with the potential to change established ways of working and the relationships between those who learn, those who teach, and those who are tasked with supporting them, such as IT support staff, quality assurance officers, business managers and accountants. The rationale for a contribution in this area is introduced through a fictitious case study created to illustrate themes revealed in the fieldwork described later:

Two lecturers within the law school at the University of Easthampton win a research grant to experiment with podcasts. Student feedback is excellent and the lecturers present convincing arguments to the school's management team that an Apple server is required for the experiment to scale. Although unfamiliar with Apple servers, the school's IT staff are supportive and see an opportunity to learn a new technology. The Apple server is purchased. However, the university's central IT unit reminds the local team that they are not resourced to support non-standard equipment and core services must take priority. Interest in podcasting grows but, as the Apple server is not ready, staff find alternative ways to create and distribute their podcasts. The pedagogical benefits of podcasting become apparent and uses vary from revision classes and feedback on assignments to publicising elective choices. Most students do not use mobile devices to access the podcasts, preferring to watch and listen in the comfort of their halls and flats, but the "podcast" label is used by all. One day the school's IT staff discover that their 'core' file server has run out of disk space. The culprit is the podcasts. Unable to use the Apple server, innovators have littered the core file server with development drafts in preparation for alternative publication solutions. The IT team ask for non-essential podcasts to be removed. Innovators are concerned their efforts are under threat. Central IT staff bemoan their lack of involvement in the platform selection, planning and sizing of the podcast activity. The school's management team receives competing versions of why the Apple server is not fully deployed. Students say in the end of year satisfaction survey that they really like podcasts and wish more staff would *produce them. A meeting is called to identify the barriers to podcasting and agree a way forward. Someone at the meeting asks if there is any research that could inform their thinking.*

This fictional account illustrates some of the challenges for m-learning innovation. To gain some conceptual purchase on those issues our first challenge is to set these issues into a theoretical context.

THEORETICAL CONTEXT

This paper adopts the view that it is useful to regard m-learning as an innovation and an opportunity to investigate how universities adopt new and potentially disruptive information technologies.

Of the theoretical frameworks available for investigating an innovation, the most established is Rogers' (1962) work on innovation diffusion, which looks at the factors that influence the successful diffusion of an innovation through an organization and the characteristics of the roles people play in that diffusion. Other models focus on the reactions of people to innovations such as Actor Network Theory (Law and Hassard, 1999), Activity Theory (Leont'ev, 1978) and Concerns theory (Hall and Hord, 1987). However, does a disruptive technology like M-Learning fit these traditional theories of innovation and technology adoption? M-learning is being introduced in many universities through externally funded projects but this begs questions about sustainability when the funding runs out. Can university organizations adapt to these challenges or will the innovation be thwarted by an unwillingness to change current practice?

The diffusion process outlined by Rogers has five stages – knowledge, persuasion, decision, implementation and confirmation (Rogers, 1995). Potential adopters must be persuaded to utilise an innovation and, following some trial period, decide whether they continue to use the innovation. Diffusion is thus not a momentary act but an ongoing process that can be studied, facilitated and supported. Categories of adopters are defined by their willingness to adopt a particular innovation, from the "innovators" who take the lead to the "laggards" who resist adopting the innovation. Attributes of an innovation are used to describe the suitability of an innovation for adoption. An innovation is more likely to be adopted if the potential adopters perceive it as easy to try out, compatible with their personal and professional goals, simple to use, better than the status quo and has demonstrable benefits (Rogers, 1995).

Building on Rogers' theory, there are numerous studies covering the adoption of information technology, telecommunications and even wireless internet technologies. Recurrent factors affecting the adoption process are the user community, characteristics of the organization, complexity of the technology, the task to which the technology is being applied and the organization environment (Cooper and Smud, 1990). Preliminary findings presented later support Cooper and Smud's interest in organizational characteristics and environment with respondents typically identifying barriers in the interface between universities' primary (learning and teaching) activities and support activities, such as the provision of infrastructure and IT services.

Cooper and Smud also highlight the impact of organizational politics on an innovation where 'rational actions serve as facades to mask political motives and to legitimise self interest' (1990, p. 136). These political interests may be significant for research into university environments, which can be subject to competition between academics for both position and research funding, invisible pecking orders and sometimes very public disagreements (Becher and Trowler, 2001). Preliminary research suggests that political positioning may play a part for both individuals who promote the technology and those who resist its introduction. Whilst Rogers' interest in an individual's response to an innovation in a free market has value, initial findings suggest that innovation responses can be influenced by the organizational context in which they are enacted. This study hopes to discover whether other literatures, such as Actor Network Theory (ANT), which seek to understand innovation in context, could offer conceptual purchase on the adoption of mobile learning in universities.

ANT introduces a concept of 'agency' (Latour, 2005) and states that agency resides both in people and objects such as innovations. Agency is usually thought of in terms of humans making conscious decisions to exert influence but ANT proposes that objects can also have agency, an example being a particular technology having influence over how humans perform certain tasks. ANT insists that all entities, both human and non-human, be subjected to the same process of social analysis (Law, 1994). ANT identifies the set of processes involved in projects of social ordering as networks and looks at the changes that take place in those networks through a project. ANT also provides a concept of translation where the people, objects and processes have specific 'needs' which are translated into more general and unified needs, enabling all needs to be met by one solution. When a system is up and running it gets adopted by the users by translating it into their own context and reflecting their work tasks and situations (Latour, 2005). For ANT the durability of such translations is important and it is possible for networks to become established that can resist competing translations, making the change irreversible.

ANT may provide a useful model for looking at m-learning in higher education as the various actors (the university, teachers, students, IT services, the innovation itself, etc.) could be viewed as undergoing processes of translation to find a stable way of working together. Notions of reversibility of current arrangements within universities and the processes of translation orchestrated by those championing the introduction of m-learning, may enable important differences to be identified between universities that embrace and implement m-learning sustainably, and those that are unable to establish 'irreversible translations'.

This review has so far concentrated on an innovation diffusion process that follows the 'non-radical' characteristics and models proposed by Rogers (Rogers, 1962). Sometimes an innovation is so radical that 'it creates a high degree of uncertainty in an organization' (Rogers, 1995, p. 426) and thus fosters increased resistance from the organization. Rogers recognizes that computer technologies often encounter 'special difficulties' (Rogers, 1995, p.426) in their implementation. Innovation can be understood as a multidimensional phenomenon where the dimensions relate to technology, market and organizational change (Green et. al., 1995) and 'environmental alterations' (Lettl et al, 2006) where environmental refers to infrastructure or regulatory changes. For example an innovation can be radical in the technical dimension if knowledge about the technology differs radically from current experience (Afuah, 1998). From an organizational perspective, an innovation may be radical if it requires the organization undergo major change in structure, strategy and culture (Lettl et. al, 2006). M-Learning might be an example of a technology that requires such a significant change to the way a university operates that it may have "special difficulties" when analysed using the Rogers model of diffusion. The idea of disruptive innovations is reinforced by the initial fieldwork and questions the adequacy of Rogers' model of diffusion for explaining m-learning diffusion and the characteristics of the innovators involved. Rogers tends to categorise innovators as having a high degree of opinion leadership (Rogers, 1995) and whilst this will be true of many m-learning innovators, it does not explain all encountered in the field research which included student-led innovation. There is significant research on so called 'bootleg' innovators where researchers 'simply ignore management directives to embark on covert action in which they (themselves!) decide to invest company resources and pursue innovation ideas' (Augsdorfer, 2004, p.1). At least two examples of innovation in the field research could be described as covert and this deserves further investigation. It is apparent that some significant organizational barriers need to be overcome to propagate m-learning and it will be interesting to compare the success of top-down, management-approved initiatives with those that have been pursued via more covert methods.

Other models have been used to look at diffusion of ICT in Education, notably 'concerns theory' which examines the concerns that different participants in an innovation diffusion process have as use of an innovation develops (Hall and Hord, 1987) and activity theory (Leont'ev, 1978; Engstrom, 1987) which is used to identify contradictions between the users needs and the institution vision of how a new innovation would be used. These theories have much in common with ANT in that they look at the innovation through the behaviour of the people using it, in contrast to Rogers where the innovation itself is the focus. The ideas behind concerns based theory reinforce the evidence from the diffusion literature that time is a significant factor and that rates of adoption vary widely between individuals and situations. This also brings to mind the concept of developing a critical mass and nurturing the right opinion leaders so that an ICT innovation crosses the 'chasm' between a trial and an established solution (Moore, 1999). It seems clear that a temporal dimension will be important for understanding m-learning adoption.

Billig identifies nine factors that engender the sustainability of an educational innovation: strong leadership, strong infrastructure, support and training, incentives, visibility of the project, credibility, mutual partnerships, macro culture development and lastly, sufficient funding (Billig, 2002). Whilst these factors are similar to Rogers' diffusion characteristics and attributes, Billig's model emphasises factors like the visibility of a new initiative and credibility in terms of demonstrating success. It will be interesting to see if m-learning initiatives are publicised within a faculty and university or whether they are localised and lack visibility, perhaps due to a fear of public failure. Billig's work also draws attention to the role of incentives in ensuring sustainability. In terms of those delivering courses, professional development, new technology and more efficient ways of working may be rewards (Billig et al, 2005), but what about the receivers of this new initiative? The preliminary field research confirms that visibility and a desire to improve student learning were recurrent themes used when describing motivations, but cases of lecturers investing time and their own money and students developing their own learning innovations beg further analysis of the notion of incentive.

METHOD

The initial field work took place between Autumn 2006 and early summer 2007 and involved face-to-face interviews at ten different UK universities. The interview subjects were involved in m-learning either because they were internationally known experts/researchers on the subjects or they had a leading role in introducing forms of m-learning into their institution Mostly these people could be described in Rogers' terms as innovators in their own environment, researching and trying to implement new learning technologies in their institution. In all of the universities visited there was evidence of local implementation of some form of m-learning. None of the people interviewed would claim to be the official spokesperson on m-learning for their institution so results are based on their personal views rather than any official position. However, an official position or strategy may be hard to come by as this comment from one respondent demonstrates: *'I took my mobile learning project to the head of IT strategy and asked if it fitted in to the institution's strategy; "You are the strategy" was the immediate reply'.*

RESULTS

Findings from the interviews were surprisingly consistent with most respondents reporting that they experienced or expect to experience the same kind of issues. These were mostly in the form of barriers to establishing and sustaining an m-learning innovation in a university environment. Issues which dominated were: Skills Gaps (both in students, IT support and especially academic staff), Lack of Technical Support (IT services provision), Procurement and Accounting Policies based around PC usage, Inclusion Issues, Ethical and Legal Issues, Quality Assurance, Sustainability (all projects were based on external funding), Device Limitations, Standards Churn, Privacy and Security, and Lack of a 'killer application'.

Skills Gap. A lot of respondents regarded this as a big problem. Many students entering university have been seen as having weak IT skills and therefore it does not necessarily follow that students will take to hand-held computing in the way that many expect. It is true that students are adept at using mobile phones but beyond messaging they may not be particularly adept at using something like a browser or a PDA interface. However, IT skills of primary and secondary school children are improving thanks to government initiatives investing in ICT in schools and colleges. There have been widespread trials of mobile learning in primary education and students have been happy to use hand-held computers because of the flexibility (JISC, 2005)

Most respondents believe that IT skills of students are improving and are likely to be less of a barrier in the future. The problem is that the IT skills of a lot of university teaching staff may not be adequate to take advantage of these new technologies and it is not clear how the IT skills of lecturers will be enhanced. Several respondents highlighted the average age of many academics as a barrier to change and learning new IT skills. Therefore the problem may evolve from a situation where academic staff generally had better IT skills than those entering higher education, to a situation where the IT skills of university teachers become the barrier. The capabilities of a user community are strongly linked to the diffusion of an ICT innovation (Cooper and Smud, 1990) but this seems to be a more complex issue in that the m-learning user community consists of distinct groups (students, teachers, IT providers) whose skills need to be in step in order to exploit the innovation. Indeed, some innovations might not come from university staff but from the students themselves. There were several examples of students innovating how they learn in the interviews - for instance, one respondent had introduced podcasting in response to student needs and another had allowed questions to be sent via SMS in lectures following student requests. Others also mentioned that students were using social networking to share ideas and understanding on sites such as Facebook and were by-passing university supplied systems such as VLEs. It appears that innovators exist both in the lecturer community and the student community with many of the factors stifling innovation coming from the university context. It will be interesting to see how this develops as students become more capable having acquired advanced skills through schools and FE colleges in comparison to academics less familiar with mobile technology.

Financing projects. There was no evidence of substantial university investment in any of the projects. All the respondents were concerned about how things would continue when research monies were spent.

Procurement and accounting issues. Those managing trials were often contemplating whether to supply mobile devices or rely on the capabilities of devices that students have. The problem with supplying devices is that the university IT departments for the most part do not want to own and manage a set of portable devices (eight out of ten respondents mentioned this). And from a procurement perspective, it is difficult to see that handheld devices can be treated in the same way as PCs. Generally PCs are depreciated over a three year cycle and can be expected to be still useful after three years. Mobile devices are likely to become out of date much more quickly and with wear and tear, a three year cycle is unrealistic. Experiments in providing devices to students have had mixed success with some devices damaged or lost, but the biggest problems have been students forgetting to have the chargers with them and losing battery power. The consensus among those interviewed is that it is reasonable to expect students to have a mobile phone and as time progresses those mobile phones will have greater capability. Some respondents cited inclusion as a potential issue. Others noted portable tablet PCs coming onto the market which are low cost (like the Samsung Q1) and there may come a point in which it could be cost effective to provide one of these devices to each student for the duration of the course, reducing the need for rooms full of desktop PCs - currently the dominant IT provision model. This type of IT business model needs further study and raises issues of security and control since the students would now have the freedom to install software on the PCs but the university would have to provide support. Probably more than any other issue, this emphasises the disruptive nature of portable computing in an environment optimized for and entrenched in supplying fixed access points. The current university IT model is based on highly-centralized structures with formal controls whereas IT innovations will tend to do better in decentralized structures with less formal controls (Pervan, Bajwa and Lewis, 2005). It might prove necessary to change the way IT is provided in universities to enable the flexibility that m-learning brings such as control over software and how support is provisioned.

Cost of downloads. This is a specific issue which many respondents felt was a problem with using mobile technologies over GSM and UMTS networks, as opposed to wireless internet services provided by the university. It is perceived as being very expensive to download information to a cell phone or PDA. As most students learning would probably involve significant downloading who will pay for this and how? If the students pay, does this render the service as not inclusive as it excludes students with more limited financial support? If the universities pay then how do they provide the service and account for the payments?

Quality assurance and data ownership. Respondents identified a number of issues in the quality assurance area. New courses are subject to internal quality assurance approval and external approval and some respondents were concerned that it would be hard to secure approval for teaching regarded as radical, as it would be unfamiliar to those involved in QA. Alternatively technology may make the work more auditable and open to scrutiny. If the lecturer is making greater use of this technology then by definition they have to encapsulate more of their teaching in the technology and thus make it open to inspection. Hence there is less informal teaching and more teaching which has to be carefully planned and documented. However these QA issues are similar to those found with e-learning which is now firmly established in most universities. A potentially more significant source of controversy is who owns the data that is produced in these mobile learning situations. For example, students on a university field trip might generate data which consists of texts/emails, notes, sound recordings, pictures and video. A tutor may wish to examine these data for assessment but the data are owned by the student and it is at the student's discretion whether she/he grants permission for the university to scrutinise it. Issues such as these were touched upon in the fieldwork, but would need further research.

Ethical and Legal issues. There is some concern from respondents about ethical and legal issues that may arise from use of mobile technology. When the university provides this mobile and wireless environment, is it somehow more liable to legal action if the students use the systems to abuse or bully staff members or each other. There is nothing to stop current technology such as email from being abused in this way but the instantaneous nature and personal access granted by this mobile technology may make this more common and more damaging to individuals. This is an issue which may occupy university boards and ethics committees in accepting this form of technology into their environment. Examples were cited from schools in terms of SMS based bullying by teenagers and examples from Higher Education such as online personal criticism of lecturers via Facebook . On the other hand some respondents felt it is just a new but inevitable risk that must be weighed against the benefits of the technology. This specific issue does not seem to have an obvious equivalent in the innovation literature other than echoes of Rogers' definition of a disruptive innovation as having the power to create uncertainty in an organization (Rogers, 1995). Several respondents feared that the universities would establish new ethics committees to look at these issues, thus creating a further barrier to progress.

Inclusion. Some respondents worry about whether use of this technology was discriminating against those who could only afford very basic phones and devices and those who had disabilities. This may be a debate within the universities as this technology becomes more prevalent. However there was generally a consensus that this was not a big problem as long as the university made other forms of access available. For example, mobile data should be accessible through other means such as the web.

Software Integration. There is a great deal of information in different IT systems which students might be expected to want access to. These include course materials, VLEs, timetabling information, and possibly student record information, such as assessment records. It is not clear how this information can be integrated into a mobile/wireless environment.

Many systems that could offer this functionality would require customization and development to make it available and it is not clear where the skills and finance to support this might come from. Some respondents were also worried about the continuing development of international standards in web technology, so-called “standards churn.” They felt this might make it difficult to create stable integrations of systems as the standards of some part or other would always be in flux.

Mode of Learning. Although this could be seen as an educational issue, the way that students learn is directly relevant to the business model of the university and the diffusion or otherwise of an innovation like m-learning. University education still largely follows a “transmission” model or “instructive” approach in that learning is controlled by the university and transmitted to the students in the form of lectures (Dakers, 2005). Nationally, education policy is trying to move towards a socially-constructed model of learning where the students have much more control over how they learn (Gilbert, 2007). Respondents quoted widespread examples of students who had set up groups (using facilities such as MySpace and Facebook) to assist each other with learning topics. Indeed some colleges and schools had actively encouraged this mode of learning. However, some respondents felt their universities had shied away from self-organised groupware tools such as Sharepoint server. Several respondents felt that universities would have to take some risks and loosen control over learning methods and IT provision in order to enable widespread m-learning as opposed to niches of deployment Respondents identified further flexibility in allowing the students more control over when they learn, but noted that this may require pedagogic change and a willingness to overcome concerns about loss of humanistic teaching traditions (Oppenheimer, 2003; Hughes, 2001). The literature suggests that innovations have better track records in organizations where the individuals share a common fate (Frank et. al, 2004). From the dynamics and pressures revealed in the interviews, it is difficult to see that staff and students would naturally see themselves as sharing a common fate.

Flexibility and work-life balance. Respondents touched upon this issue, echoing abundant evidence from the business world that mobile technologies have the potential to extend working hours and blur the boundaries between work and leisure time. Blackberry email devices are one example where people may feel compelled to deal with emails even when their working hours are officially over. The same concerns exist amongst respondents for mobile learning. If students enjoy more freedom over when they learn then how can we be sure that this will not impinge on teaching staff? Perhaps the issue of incentives should be examined here. Students’ incentives for the innovation are the obvious flexibility and it is difficult to see how they can lose out. On the other hand innovations are often thwarted if there is no obvious incentive for the staff (Billig, 2002).

Disruption. In addition to “disruption” to the process and business model, mobile devices represent a real threat of disruption in teaching situations. It is already a well known problem that students use their mobile phones during lectures but this is generally forbidden by university policies. According to anecdotal evidence from several of the respondents, students have been prevented from using mobiles to video/record lectures which was a legitimate attempt by them to improve their chances of understanding the lecture. Many of the examples in this paper could be seen as e-learning using mobile devices rather than pure m-learning, but mobile computing has the potential to emerge as a different pedagogy which challenges and disrupts established conceptions of teaching.

Niche deployment/lack of killer application. Many respondents felt that the search was still on for applications and devices that would make mobile learning so unique the universities had to embrace it. Some predicted that mobile learning would develop in niches before eventually spreading to the masses.

CONCLUSION

This research started with the premise that a disruptive technology like m-learning might not fit traditional theories of new technology adoption in Higher Education. From the evidence so far, there are some major potential mismatches between the technology, the skills of the people involved and the way that the organization (university) is structured. At the current time there is little evidence that universities are investing significant sums of their own money in m-learning technologies (apart from some implementations of podcasting) so the activity is taking place in funded research projects and has thus largely been able to exist outside of the influence of potential barriers such as IT services, finance, and ethics and QA committees. In ANT terms, none of these ‘actors’ has been subject to any form of durable translation as the projects have been conducted as research activities. Evidence that they can is not promising with IT Services in nine of the ten interviews refusing to get involved. There is also a shifting mismatch in skills and expectations between the lecturers and the students especially as students will start to enter universities with knowledge of mobile learning acquired through a combination of experience in primary and secondary education and developments in social networking.

The more surprising issues which the research revealed were: the skills mismatch problem, the business model issues and the conflict with the IT provision model all of which will be explored via further case studies. Looking at the ten institutions which were interviewed and evidence of projects in other universities, there are broadly three categories of project at work:

i. Projects that are funded through external research grants. The issues here are how the project evolves from being funded externally to being funded and approved by the university. In ANT terms, how do the actors translate themselves through this process?
ii. Projects that are funded by the university and have some level of support albeit more faculty based. Will this type of project sustain itself after the initial burst of enthusiasm?
iii. Projects that are introduced almost covertly by individuals using their own effort and even own finance. How will the actors transform themselves from covert operation to something which diffuses and becomes acceptable to the wider university community? Will their initial covert nature engender an insurmountable resistance from the university management and administration?

This is a work in progress. The next stage is to perform some detailed case studies on live projects ideally covering the three types of cases outlined above. If m-learning is viewed as a disruptive innovation then in order for it to succeed, a range of departments, staff and policies must undergo change before it becomes an irreversible feature of the university environment. In ANT terms, these are all actors in a network and must undergo a set of translations. ‘Mediators and intermediaries’ will have to form relationships so that the processes and departments translate into a network (Latour, 2005, p.40). For the technology to become established, the actors must undergo irreversible change (Callon, 1991) and that degree of irreversibility will depend on whether it remains an isolated example or whether it sustains and starts to shape and determine subsequent translations (Callon, 1991, p.159).

Whilst ANT and its notions of networks and translations appear promising for exploring how these barriers can be overcome, another part of ANT may be even more so. Looking at project failure in the aircraft manufacturing industry, Law and Callon came up with the concept of local and global networks and the boundaries between the two (Law and Callon, 1992). They identify three factors which influence the success or failure of the project with the most significant being ‘the capacity of the project to build and maintain a global network which will for a time provide resources of various kinds in the expectation of an ultimate return’. They also talk about points of passage between the two networks which again looks like a relevant concept.

In m-learning, it is perfectly feasible for a student to innovate, a lecturer to support the innovation and their interaction to form a local network where the students and lecturers cooperate. A good example is using text messaging of questions in lectures, something which in isolation does not require other actors in the university to approve or participate in. But this process eventually interacts with the global network as the practice spreads to other lecturers/faculties and teaching and ethics committees and perhaps unions start to debate whether this is acceptable practice, whether there are inclusion issues and so on. Therefore significant factors will be the ability of the local network to build links with the global network and influence the global network to approve and support the innovation. Actors, be they individuals or even artifacts, must become points of passage between the two networks for that influence and support to be achieved.

There are several potential contributions to knowledge from this work as it develops in terms of expansion of innovation theories and indeed new uses of Actor Network Theory. In terms of practice, it is hoped that the work will eventually highlight critical success factors for making an m-learning project sustainable in a university environment and thus aid those embarking on such projects.

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MobilED: A Tool by Any Other Name...

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ABSTRACT
Designing, implementing and evaluating educational technology for a developmental project in mobile learning is largely unchartered territory. This paper reflects on the process, the role-players, their contributions and the framework that was adopted to co-ordinate and focus the team's efforts in the design of the initial prototype of a Information Gathering and Lesson Tool (IGLOO) as part of the MobilED suite. MobilED is an international collaborative project aimed at creating meaningful learning environments using mobile phone technologies and services. The paper expands on the use of the activity theory to guide the design of a learning environment and the incorporating of a tool dimension (social-technological dimension) in an effort to knit the technology perspective to the pedagogical aims. The usability, usefulness, formation of virtual learning spaces and communities are explored and contextualize by the results found using this framework.

Author Keywords
Mobile ICT, Mobile learning, mobile technology, development, educational technology, activity theory, conceptual framework

INTRODUCTION
From an African perspective, factors such as the general lack of infrastructure, sporadic supply of electricity, lack of skilled technical support, the high cost of installing and maintaining a network and the easy to use interface of mobile phones have contributed to the high rate of adoption of mobile technology (Traxler & Leach, 2006, p.6.2). This demand is still growing (Scott, Batchelor, Ridley, & Jorgenson, 2004) Mobile phones are set to be the most important networked knowledge exchange technology used in Africa (MobilED, M Ford & Botha, 2007a, "Mobiled ", 2006). This combined with afore mentioned limitations are the most important considerations for using mobile phones as potential learning tools (M. Ford & Botha, 2007b). This paper gives a brief introduction to MobilED's use of development research methodology and motivates the adoption and the expansion of **the activity theory** as a conceptual framework. A discussion expands on the incorporation of "tools" as a component and the implications of the ensuing mediated components.

MobilED
MobilED (Mobile Education) is an international collaborative project aimed at creating meaningful learning environments using mobile phone technologies and services(MobilED Research Framework, M Ford & Botha, 2007a; MobilED Research Framework, "Mobiled research framework." 2005). The MobilED project has four key scientific, technical and developmental objectives:

1. To explore and comprehend the cultural, social and organizational context of young people in and out of school in three developing countries (South Africa, India, Brazil) and in one developed country (Finland) as they utilize their mobile phones.
2. To develop research-based models and scenarios of how mobile phones could be used for teaching, learning and the empowerment of students within and outside the school context.
3. To develop concepts, prototypes and platforms that will facilitate and support the models and scenarios thus developed.
4. To test, evaluate and disseminate the scenarios, models, concepts, prototypes and platforms (MobilED research framework, "Mobiled research framework." 2005)

The *challenge has been to use the unique capabilities of the mobile* phone as technology tool in a pragmatic way and not to try and emulate the functionalities of a desktop computer. The research has focused on developing scenarios in general and South Africa in specific (Leinonen & Sari, 2006)

Designing for development presented specific problems and challenges for the research team consisting of programmers, educational researchers, educators, project managers and other institutional committees. As a diverse group of role-players it was important to ensure cohesion and to develop a common vocabulary and understanding of field specific; concerns. The notion of what was possible, probable and eventually reachable within specified boundaries needed to be, facilitated.

The development of prototype technology was to be grounded in local context and fed by both the appropriate pedagogical models and the potential of the technology itself. There emerged a dual nature to our research as we negotiated the incorporation and facilitation of both the technology and pedagogy. This dual nature of mobile learning is well documented (Ahonen, Pehkonen, Syvänen, & Turunen, 2003; O'Malley, Vavoula, Glew, Taylor, Sharples, & Lefrere, 2003; Schwabe & Goth, 2005; Syvanen, Beale, Sharples, Ahonen, & Lonsdale, 2005; Zurita & Nussbaum, 2004) The focus of the individual research often narrowed to either technology or pedagogy.

There is no consensus in literature as to a definition of what mobile learning is and its identity rather lies in the unique possibilities that this learning technology is able to support. In general, however, technology-driven research tends to defines mobile learning in terms of learning by means of mobile devices and this emphasis on technology influences and extends to the definition of learners, referred to as "m-learners" and their interaction with the technology as "acquire and learn through a wireless transmission tool anytime and anywhere" (Chen, Kao, Sheu, & Chiang, 2003).This view contrasts sharply with research driven by pedagogical concerns where mobile learning is approached in terms of an enriched or extended learning environment (Rochelle, Vahey, Tatar, & Penuel, 2003; Young & Vetere, 2005).

The negating of the importance of the pedagogical implications for a mobile learning environment has proven disastrous and resulted in "almost total lack of adoption by **users** (Er & Kay, 2005)." It leads to the conclusions that the pedagogical underpinning and the technology that assist it are interdependent. Focusing on only one of the perspectives inevitably creates discord as a pedagogically sound mobile intervention cannot take place without acknowledging the technology to support it. In the same way a brilliant technological tool unsupported by sound pedagogic is educationally useless.

In the MobilED initiative the aim was in developing not only technology but learning scenarios as well. Addressing mobile learning from a pedagogical perspective (perhaps best described as a descriptive endeavour) as well as from a technology perspective (a constructive or engineering endeavour). This needed to be reflected in the planning and eventual assessment of the "technology in action". Our research group needed a new approach to integrate and navigate these perspectives the resulting creative tension between the two disciplines. This while still taking into account the lessons learnt from the developed world, but contextualizing them in the realities of Africa.

Activity theory as theoretical framework

A literature survey revealed that the implementation of mobile technology in an educational setting is beset by the same challenges as other fields of study such as HCI, where people act with or through technology. Kaptelinin and Nardi (2006) emphasizes that the activity theory is a useful theoretical framework for negotiating the complex structure of users and their needs on the one hand, and the technology and its possibilities on the other, thus incorporating the dual nature of implementing mobile technology into education. Furthermore the underlying tenets of the activity theory, which are encapsulated in the notion of people acting with technology, strongly reflect the social constructivist underpinnings of our research. These are:

- the intentionality of human action;
- the asymmetrical view of people and the things of the world;
- the acceptance of human development; and
- the shaping of culture and society by human activity (Kaptelinin & Nardi, 2006, p.10).

Activity Theory

Nardi (1996) describes the activity theory model as a powerful, clarifying descriptive tool rather than a predictive theory(p.4). Activity theory does not attempt to pass itself of as a theory of learning; instead Engeström's (1987) theory of expansive learning incorporates activity theory-orientated pedagogical concepts. Mwanza and Engeström (2005) states that :

This perspective on teaching and learning highlights the potential impact of new tools as vehicles for transforming activity and also of those engaged in activity (p.458)

The Activity theory acknowledges and seeks to understand the unity of consciousness and activity. It's origin is as a social theory of human consciousness and views interaction with people and artifacts in the contest of everyday practical activity as the result of that consciousness (Kaptelinin & Nardi, 2006, p.8).

Vygotsky, distinguishes between two types of mediating agents in human activity, technical tools and psychological tools states in connection to technical tools:

The tool's function is to serve as conductor of human influence on the object of activity; it is externally orientated; it must lead to changes in objects. It is a means by which a human external activity is aimed at mastering, and triumphing over, nature. (Vygotsky, 1978, p.55)

His psychological tools have different nature:

It is a means of internal activity aimed at mastering oneself; the sigh is internally oriented. (Vygotsky, 1978, p.55)

Both these categories of tools mediate activity and the distinction between the tools as a means of labour and tools as a means of social intercourse are acknowledged (Engeström, 1987, p.60; Vygotsky, 1978, p.54)

An activity is undertaken by a human agent (subject) who is motivated toward the solution of a problem or purpose (object), and mediated by tools (artefacts) in collaboration with others (community). The structure of the activity is constrained by cultural factors including conventions (rules) and social strata (division of labour) within the context (Ryder, 1998, p.4).

These different components are shown in Figure 3 below. The expanded triangle model of Engeström ((Ryder, 1998, p.4) is based on the concept of *"activity based on material production, mediated by technical and psychological tools as well as by other human beings (Engeström, 1987, p73)."* From this Engeström incorporates the **community** as an additional component of human activity, placing tools in a mediatory relationship to intentional human interaction. In terms of this theory, human activity is attributed to the specific needs that human beings have to accomplish objectives. The activity then is mediated by one or more "tools" and is reflected through people's actions as they interact with their environment.

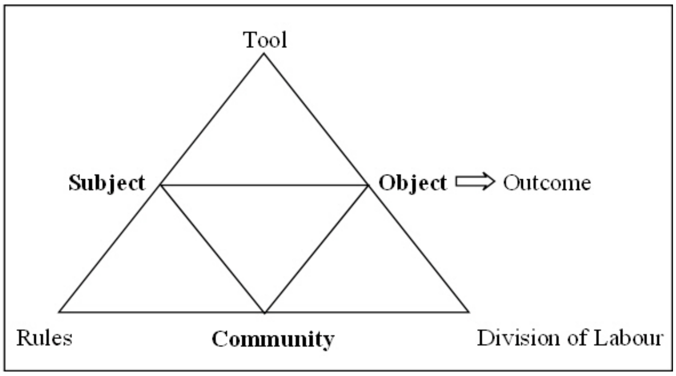

Figure 2: Engeström's Expanded Triangle Model (Mwanza & Engeström, 2005)

From this the students as users are portrayed as the subjects interacting with objects to achieve desired pedagogical outcomes. These object orientated activities of the users are mediated within and between the users in a given *community* of practice. The mediators are the rules and division of labour and represent the nature of the relationships that exist (Mwanza & Engeström, 2005).

The mediating tool as component

In contrast to the activity theory view of a tool, Marshall McLuhan (1994) asserts that :

(It)...merely underlines the point that "the medium is the message" Because it is the medium that shapes and controls the scale and form of human association and action (p.9).

With this dictum, he confirmed the link between the medium used and the user who uses the medium. The idea that the technology more than mediates an activity but also changes the subject is raised several times by Marc Prensky (2001b):
It is now clear that as a result of this ubiquitous environment and the sheer volume of their interaction with it, today's students think and process information fundamentally differently from their predecessors. (p.1)

This sentiment is repeated in Educating the Net Generation (Oblinger & Oblinger, 2005):

"The technologies available as a generation matures influence their behaviours, attitudes, and expectations (p.6.2)."

Technology becomes more than merely a means that allows an activity to take place; the technology contributes to the nature of the activity, affects the social interactions of the users and the community in which these interactions take place and ultimately allows access to virtual environments in which many of the activity will take place.

Kaptelinin and Nardi (2006) acknowledge that the concept of tool falls short of expanded activity describing all types of technology, arguing that some applications can be considered more an environment, and comes to the conclusion that some artefacts seem to not be tools. They suggest that these environments be seen as mediating the relationship between subject and object. These ideas they however dismiss as, "*environments*", from an activity theory perspective, are understood as "*the world with which the subjects interact (p.255).*"

The object orientated action of a user utilising, for example, his mobile phone to mediate an activity, is subject to various protocols, rules and norms as a result of the technology and the virtual communities that are accessed. This is especially true when considering mobile technology because of the personal nature of the technology and the frequent overlap of the real and virtual worlds. (Botha, Cronje, & Ford, 2007; Rochelle et al., 2003; Schwabe & Goth, 2005). To this end we propose the incorporation of technology as a component in the activity (Botha, Ford, Aucamp, & Sutinen, 2007) as represented in Figure 4 below.

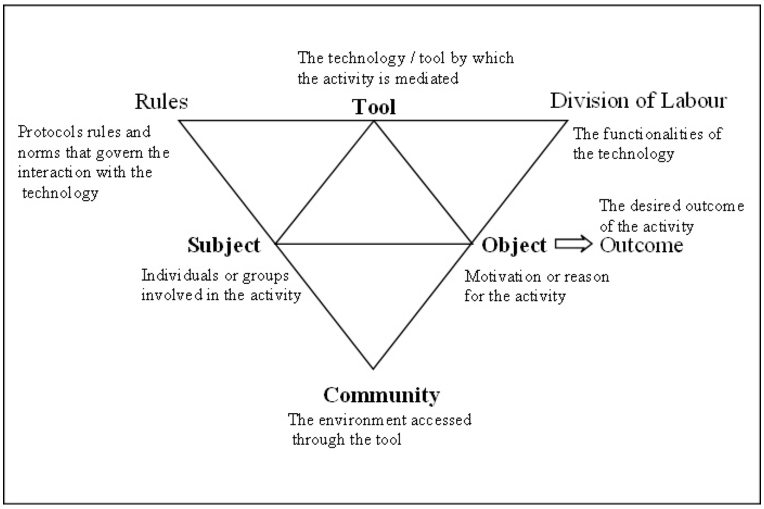

Figure 3: The technology tool component with meditational relationships

The Figure 4 above is a representation of the technology dimension that comes into existence when the "technology tool" is incorporated as a component in the activity.

ANALYSIS

The incorporation of technology as a component into Engestrom's (1987) extended activity model offers a new perspective on human activity with technology and provides an additional set of concepts for describing and understanding those activities. In order to further the discussion a brief overview of the components and their ensuing mediating relationships are given.

Subject component

The user as subject in the physical world acts with and through technology.

In activity theory people act with technology; technologies are both designed and used in context of people with intentions and desires. People act as subjects in the world, construction and initiating their intentions and desires as objects. Activity theory casts the relationship between people and tools as one of mediation; tools mediate between people and the world. (Kaptelinin & Nardi, 2006, p.10)

The intentional object orientated activity initiated by the user holds in the physical world as well as in virtual environments and communities. Although the human as subject can only enter these communities through the mediation of the tool the intention to act is still situated within the person. The tool as technology can prompt the person to act but the final motivation or intention to act is still that of the individual as user.

Mobile technology, because of its personal and portable nature is often used by individuals to organise their day, but it is still the user who initially instigates an action. For example an alarm that acts as a reminder is initiated by the user and the user still has the final will to act on the alarm or to disregard it. The reaction of the mobile technology is initiated by the original action of the individual.

Object component

The object is the motivation for the intentional interaction of the human activity. The object focuses the actions of the user and provides an incentive for the activity. The sending of a sms might initiate a number of interactions with the technology and provides the incentive for these actions. If the user is unable to navigate the rules, protocols and functionalities of the device the objective cannot be achieved and the user experiences frustration.

Community component

The community that contextualises the activity is either the real world or an environment that can only be accessed through the application of the technology tool. This virtual world is characterised by instances where it "leaks" into the real physical world. This virtual world provides the arena for the activity with instances where it overlaps the real world. The individual can for example, be absent from the real world community but still present in the virtual community or present in both at the same time. The virtual environment tends to be 24 hours seven days a week presence as, often, people from different real world time zones construe such communities. With some users and uses of technology it is possible to be present in the virtual world and the physical world, for example carrying on a instant message conversation while being in a lecture.

Tool component

In activity theory, the analysis of tools includes the actual use to which tools are put as well as the setting in which this process occurs. *"For the tool reveals itself to us fully only in use"*(Bannon, 1985). Activity theory interprets a tool as an artefact that people use to perform activities. By extension tools may also be understood not only in terms of the *use* to which they are put also the *access* the user gains. Furthermore the technology has no meaning in isolation; meaning comes only through the incorporation into social and cultural practice.

Bannon continues to say that a tool works well if it allows the subject to focus on the object without the subject itself becoming the focus of attention (Bannon, 1985) This approach describes how technology appears to its user *in use* (Nardi, 1996). The mobile phone only has use in the context of how usable it is for the individual. When a student want to access a mobile community the mobile phone itself becomes the vehicle through which this action is made possible. The mobile phone is however not the community or the access.

Reflecting that "The tool component" is comprised of the technology or tool used to mediate the intentional object orientated action of the individual to achieve a specific objective, its incorporation results in two new mediatory relationships. To distinguish between the tool component and the community component the meditational aspects will be termed the tool rules and the tool division of labour. These are briefly discussed.

Tool rules:

This relationship is characterized by norms, rules and protocols that regulate the user's interaction. These "tool rules" mediate the subject's interaction with the technology. Examples of such rules that govern the use of mobile phones as tools are predictive text for sending SMS and the variants in navigation found in the interfaces of different models of phone. Holzinger, Nischelwitzer, and Meisenberger (2005) states:

The phenomenal growth in mobile computing, whereby a parallel growth of user sophistication has failed to take place, will increase the need for future research in fully adaptive and sensitive interfaces, aware of the requirements and proficiency of users (Conclusion and Future Outlook).

This relationship reflects the arena where the user interact or meets the technology and the user interface lies within this mediating relationship as "user-system" interaction, a too narrow a phenomenon to construe an activity (Kaptelinin & Nardi, 2006). Reflection on this relationship offers the researcher opportunities to incorporate not only the ease with which the user interacts with the technology but also the nuances in usage occasioned by each variant form and functionality of the technology. This would enable an understanding that not only acknowledges the user's possible ignorance of an interface or a technology but places it into a design perspective as subject to the activity.

These rules can be explicit, as are classically incorporated in user manuals provided with new technology, or apparently implicit as in predictive text. Failure by a user to navigate these rules renders the technology useless to the user. The `Net generation'(Oblinger & Oblinger, 2005) or `Digital natives' (Prensky, 2001a) prefer not to read instructions and intuitively navigate these interfaces by trial and error (Oelofse, De Jager, & Ford, 2006).

Tool division of labour

The relationship between the tools and the object is characterized by the specific abilities of the technology to support the user in achieving his objectives. An example of such mediation would be the use of a video by one pupil to record an event, where another pupil might have had to use a voice recording because their phone does not support a video function. The relationship can thus be interpreted as the specific functions of the tool that can be accessed to reach a specific outcome.

This relationship offers researchers opportunities to reflect on the functions that are available and their adequacy in relation to the object. It would also direct the formation of groups in situations where there are limited resources and a pooling of resources are needed. An important consideration in disadvantaged communities where insufficient funds are available for the financing of educational initiatives.

USABILITY AND USEFULNESS

Deliberation of concept

Ideally technology should support the individual in his endeavours to realise his intensions through the tool. According to Sneuderman (2002):

Successful technologies are those that are in harmony with user's needs. They must support relationships and activities that enrich the users' experiences. Information and communication technologies are most appreciated when users experience a sense of security, mastery, and accomplishment (p.2).

For technology to have an impact on education, it should be designed in such a way as to support the actions of the participants in day to day educational practices (Gifford & Enyedy, 1999; Kaptelinin & Nardi, 2006). Considering a definition for the usefulness of a tool as the extent to which the tool supports the intentions of the individual, it can be mapped on the social technological perspective of the activity theory as in Figure 5 below.

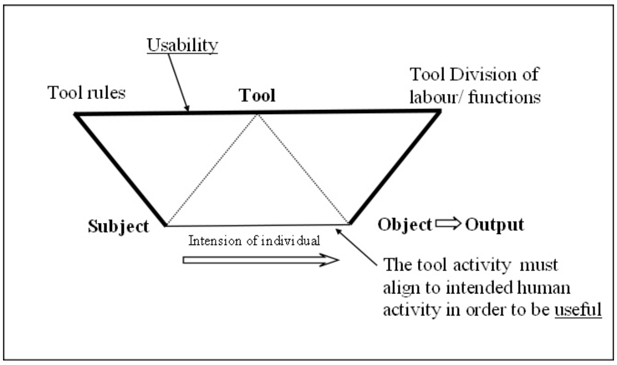

Figure 4: Usability and usefulness of a technology tool

In Figure 5 the object provides the motivation for the subject's directed intention (Engeström, 1987; Kaptelinin & Nardi, 1997, 2006). This motive translates to operations, actions and activities performed by the individual. However if these operations can only be negotiated through the tool, the relationships mediated by the tool as component come into play. These relationships are the "tool rules": the user interface and the rules and protocols associated with the technology, and the "tool division of labour": the functionalities or capabilities of the tool.

For each separate function of the tool there will be a separate set of rules, norms and/or protocols that the user needs to navigate. So for example, in single function tools, there will be only one set of rules, norms and/or protocols. In mobile phones the different functions tend to have only one set of navigation rules and contribute to the ease of use of this technology. The usability delivers a perspective as to the user's ability to successfully negotiate these two meditational aspects. If a user is termed skilled with a given technology it would then imply an ability and fluency to navigate the tool rules and the functionality of a given technology. The extent to which the user will be skilled in the use of other technology depends on the similarity of the meditational aspects of the new technology. The usefulness of the tool can be interpreted as the alignment of the activities that the tool can support with the intended activity of the person; however, the usability of a tool does not guarantee its usefulness. An objective which would necessitate the use of diverse functionalities, each with subsequent rules of engagement would not be appropriate technology for a novice user. If, however, such technology is introduced if would seem the best course of action to first introduce the functionalities and rules associated with each, individually, to minimize user stress.

Virtual Communities

Development viewed from the activity theory perspective is a socio-cultural endeavour but also influenced by technology as it becomes more imbedded in our society. Some socio-cultural activities are so totally immersed and dependant on the availability of technology as tool that they can be viewed as a social-technological activity. People are not only acting *with* technology (Kaptelinin & Nardi, 2006, p.10)but *through* technology. For example online communities, virtual spaces and environments cannot be accessed without engaging with technology and the failure of technology to support this access and ensuing interactions cause a breakdown in the activity. In the event of the unavailability of alternative paths to facilitate the activity the activity cannot take place. This concept of tool accessed communities is illustrated briefly.

The loss of a phone by a teenager is often met with exaggerated emotion (Oelofse et al., 2006). The implications are however that the individual, irrespective of the motivation, cannot access or take part in activities in the virtual environment. He is so to speak out of the "social loop" The technology becomes more than a mediator it is the "portal" through which the individuals object orientated activities take place.

The individual accessing his emails is actually accessing a virtual community (Ducheneaut & Bellotti, 2001; Kaptelinin & Nardi, 2006) through the use of technology. This virtual community is superimposed over the real world. Ducheneaut and Bellotti noticed *"that even when collaborators work in plain sight of one another as in MediaWorld's open-plan spaces, they still send each other a good deal of e-mail (p.7)."* This virtual environment can be accessed in various ways from alternative real world sites but exists only virtually and access is gained by acting through technology. From a developing countries perspective this paints a very bleak picture as the lack of suitable technology immediately implies the total exclusion to virtual communities and environments and the activities that take place in them. From a developing countries perspective this paints a very bleak picture as the lack of suitable technology immediately implies the total exclusion to virtual communities and environments and the activities that take place in them.

CONCLUSION

What implications would this extension to the activity theory hold for design and implementation of mobile learning piloting? The relationships that unfurl and present themselves are primarily another tool in researcher's repertoire to further understanding of phenomena. These relationships are best viewed as interrelated and part of a whole. Presenting the interactions of users with the technology and community can be presented as in Figure 6 below.

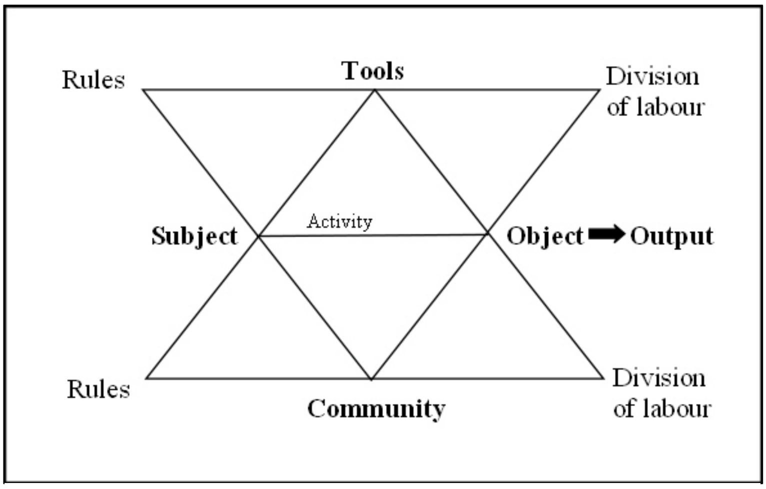

Figure 5: Technology incorporated as component.

This representation aims to incorporate the technology as a means by which the user mediates activities but also as a means by which the user accesses environments. It allows researchers to view the technology in situated action so to speak while reserving a place for the individual as the initiator of interaction, recognizing the importance of the users experience and intentionality unique to humans. The community that comes into being when individuals act through technology, results in a blended real world/virtual world environment that overlaps and influences each other. The user's ability to simultaneously habitat both worlds are incorporated in this way.

Enabling designers, researchers, funders and practitioners to speak a common **language while allowing for the interests of all the role players,** make for more productive collaboration. It enables the pooling of resources towards a common understanding of the desired outcome and lays the groundwork for discussions. This design is by no means meant to be a panacea but rather a lens for understanding.

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“Digital Life Skills” For the Young and Mobile “Digital Citizens”

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ABSTRACT

Technology has changed the world we live in and has come to be both villified and acclaimed, often for the same reasons. Whilst mobile phones in particular, have tremendous potential as knowledge exchange devices in the developing world due to their accessibility, usability and universality, there are many issues that need to be resolved when using them in an educational environment. The MobilED iniative, which strives to apply mobile phones as tools to support development, focussing on impacting the education system in the short term, has shown that technology is not value free and piloting technology without considering the impact on the community is a short-sighted approach. This paper reflects on the development perspective of implementing a mobile phone initiative in an educational environment and suggests the activity theory as a lens to broaden practitioners' understanding and sensitivity to issues that come into play when learners are empowered with alternative access to information and communication. Insights gained from the MobilED initiative are articulated and we reflect on the implications on other mobile learning initiatives in general and in developing context specifically. The concept of “Digital Citizenship” is discussed and various mechanisms are suggested in order to prepare children with “digital life skills” so that they may safely and confidently become full members of the knowledge society.

KEYWORDS
mobile phones, community, impact, development, digital citizenship, digital life skills, mobiquette, knowledge society

INTRODUCTION

> *“Today's students have not just changed incrementally from those of the past, nor simply changed their slang, clothes, body adornments, or styles, as has happened between generations previously. A really big discontinuity has taken place. One might even call it a "singularity" - an event which changes things so fundamentally that there is absolutely no going back. This so-called "singularity" is the arrival and rapid dissemination of digital technology in the last decades of the 20th century.”* (Prensky, 2001)

This statement is particularly true in Africa today if applied to society in general, where the advent of the mobile phone has had a vast impact on millions of lives on the continent. Historically, Africa and its people have faced many practical problems in their race towards digital inclusion and economic progress, such as a severe lack of infrastructure and resources. Most of the existing traditional telecommunications infrastructure in the continent cannot reach the bulk of the population, with 50 percent of the available lines concentrated in the capital cities, where only about 10 percent of the population lives. In more than 15 countries in Africa, over 70 percent of the lines are still located in the largest city (Jensen, 2002). Generally the level of technology penetration in Africa is low compared to developed countries, primarily because the general population cannot afford it (Beute, 2004).

However, the arrival of mobile and wireless technologies is rapidly changing this, and the mobile phone, in particular, is set to have a major role in the stimulation of the information society in developing countries (Ford and Leinonen, 2006). According to the International Telecommunications Union, Africa’s mobile cellular growth rate has been the highest of any region over the past 5 years, averaging close to 60% year on year (ITU report, 2006). The total number of mobile phone subscribers continent-wide expected by the end of 2008 is 316 million, which equates to a penetration rate of 34%

(Engineering News, 2008). The economic and social benefits of mobile phones are evident at all levels of society and the penetration rate of mobile phones is significant, given the fact that access is often shared (Vodafone Policy Paper series, 2005).

MobilED (initially *Mobile EDucation*) is a collaboration that began in 2006 between the South African-based Meraka Institute (CSIR), University of Pretoria, Tshwane University of Technology as well as various international partners such as the Media Lab of University of Art and Design Helsinki (Finland), Escola do Futuro Universidad de São Paulo (Brazil) and the WikiMedia Foundation (United States). The initial aim of the initiative was to develop, expand and integrate mobile-phone tools, technologies and services into the areas of formal and informal teaching and learning environments.

MobilED's goal of expanding the use of mobile phones within the education system is in order to prepare learners for full participation in the knowledge society, towards the acquisition of 21st century skills. In the absence of desktop computers and ubiquitous internet access, mobile phones have the potential to provide an alternative access and participation mechanism for those on the wrong side of the "digital divide". Mobile phones can be considered the most important networked knowledge exchange technology used in Africa today. From a developing country perspective, features such as limited or no dependence on permanent electricity supply, easy maintenance, easy to use audio and text interfaces, affordability and accessibility are the most important considerations for using mobile phones as potential information and communication technology (ICT) tools (Vodafone Policy Paper series, 2005). Over the past year it has become apparent that many of the initiative's innovations have a much wider application in the developing world and the concept and MobilEd acronym has undergone a change of emphasis to become "*Mobile-Led",* pronounced *"Mobi-led"*. A "MobilED Suite of Services" is being developed and customised for various domains, such for the health, government, SMME (Small, Medium and Micro Enterprises) and NGO (Non-Governmental Organisations) arenas.

In order to ensure seamless integration of the mobile phone as a useful tool in various domains, it is important to understand the engagement of the target users and organisations with mobile technology and measure the outcomes of the intervention. This makes it possible to apply that knowledge to improve future designs and usage possibilities. It also stimulates new ideas, concepts and applications. The MobilED team is investigating various mechanisms and frameworks, such as the "harmonization cube" developed by the European Network of Living Labs (EnoLL) (Mulder et al, 2007) and the "Outcome Mapping methodology" (as designed by IDRC in consultation with Dr Barry Kibel of the Pacific Institute for Research and Evaluation as an adaptation of the Outcome Engineering approach). The idea is to develop a methodology or framework for technology interventions that can be applied in a developing world context.

In the specific application of mobile phones and services to an educational domain, the MobiLED team is using "Activity Theory" to move the focus from the technology to an understanding of mobile technology as part of a larger scope of human activities within the educational system. Past initiatives have shown that by "acting *with* technology, both possibilities and responsibilities expand". The introduction of mobile technology in areas of limited and no connectivity is subject to various cultural historical influences that need to be taken into account for any sustainable implementation.

This article briefly expands on the activity theory as a conceptual framework for the understanding of socio-cultural factors that are influenced by, and influences the implementation of mobile technology in a community, specifically the educational community. The concept and necessity of what the team has termed "Digital Life Skills" and the concept of "Mobiquette" as preamble to any implementation is discussed from a South African context and suggestions are made to practitioners in this field.

ACTIVITY THEORY

The roots of the activity theory may be located in the 18th century German philosophy of Kant and Hegel. Their work emphasises both the historical development and the active role of human beings in constructing ideas (Jonassen & Rohrer-Murphy, 1999).

The basic principles of the theory include the hierarchical structure of activity, object-orientedness, internalisation/ externalisation, tool mediation, and the notion of development. In terms of this theory, human activity is attributed to the specific needs that human beings have to accomplish objectives. The activity is then mediated by one or more "tools" and is reflected through people's actions as they interact with their environment.

An activity is undertaken by a human agent (subject) who is motivated toward the solution of a problem or purpose (object), and mediated by tools (artefacts) in collaboration with others (community). The structure of the activity is constrained by cultural factors including conventions (rules) and social strata (division of labour) within the context.

This distinction between activity, action and operation is the basis of the three-level model of activity described by Leoniev who never undertook to expand to describe or his theory in detail. It was Engeström who extended Vygotsky's original conceptualisation to include the ideas of Leoniev. This expanded third development of action theory incorporated the idea of *community*. This resulted in two new kinds of relationship: the relationship of community-subject and the relationship of community-object. According to Engeström, the community-subject relationship is mediated by *rules* and the community-object relationship is mediated by the *division of labour* . This is illustrated by Figure 1 below:

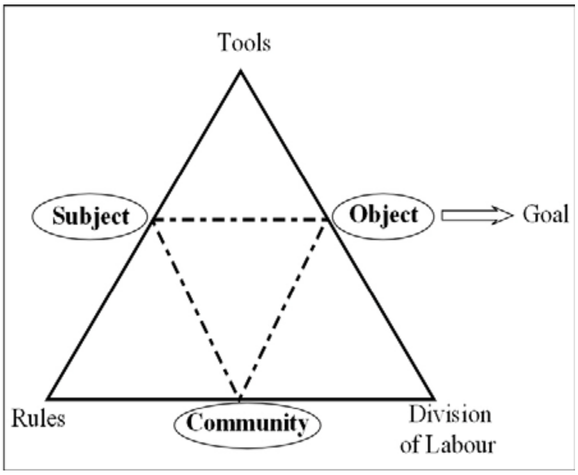

Figure 6. Expanded triangle of an activity system (Engeström, 1987)

The extended mediated relationship between the subject and the object offers a general model for human activity that reflects the collaborative nature of human actions. The "nodes" taken from Engelström's model depicted in Figure 1, are:

i. *Subject*: This refers to an individual or group that is the central driving character in defining the activity. With reference to pilots that have been completed in the MobilED initiative it refers to learners, educators, groups consisting of either only learners or only educators and a mixture of them.

ii. *Object*: This refers to that towards which the activity is directed eg. the task set for the learners

iii. *Tool/s*: These may be either external or internal mediating instruments. For the discussion of this paper it is taken as the mobile technology tool.

iv. *Rules and regulations*: These are explicit and implicit regulations, norms or conventions that constrain actions and interactions within an activity. These are the management structures that the organization i.e. the school or university may institute to manage the use of the technology and the historical norms that relate to the technology. Often in development initiatives there are no historical – cultural norms that guide interactions with the technology and some type of structure needs to be agreed on before initiatives pilot.

v. *Division of labour*: This refers to the division of tasks between members as well as to a division of power and status. As mobile technology is often adapted more easily by learners than by educators it may impact negatively on the integration of mobile phones in strictly authoritarian communities as the educator is often placed in a position to learn from their students.

vi. *Community*: This refers to multiple individuals or sub-groups that share the same general object. It relates to the class, the school and in large the community on which the technology eventually will impact.

DIGITAL LIFE SKILLS

"Activity is a historically developed phenomenon. That is, activities evolve over time within a community " In the context of this paper this highlights the fact that the social uses and integration of technology is a phenomenon that integrates into a culture over time. This is a major issue that needs to be taken into account whenever introducing a new technological innovation into a community. In South Africa, where the majority of the people are "digitally excluded" or where there is a "digital divide", this issue becomes even more critical. When the integration of technology is artificially speeded up by an intervention (such as using mobile phones for learning support) this often creates problems within the society. Very often the technology itself is blamed for these problems.

This can be illustrated by the popular media attention focused on some of the negative issues regarding mobile phones, particularly in the hands of children. Many schools in South Africa are either banning mobile phones from school premises or locking them away during school hours. A popular instant messaging service, known as "MXit" which enables text chatting via mobile phones at a fraction of the cost of normal SMS messages, has taken the youth of the country by storm. The latest published figures indicate more than 5.8 million users, of which 45% are in the 14 – 18 year-old age-group (Mail & Guardian Online, 2008). Media reports state that this has led to inattention in class and the exposure of teens to sexual predators. In addition, mobile phones are also being used to videotape violent fights between children in schools and there are reports of children distributing pornography via their phones (Mail & Guardian Online, 2007). This is reminiscent of the early days of the internet in the 1990's and much of the controversy regarding these devices is similar to the debates that happened and are still happening in the developed world regarding the social networking phenomenon. The major difference is that mobile phones are the device of choice in the developing world versus the ubiquitous networked computer in the developed world.

Children seem to have a natural and intuitive ability to comfortably use and integrate technology, whether or not they have access to it on a daily basis. This can be well illustrated by one of the MobilED pilots. The pilot was run at Irene Middle School in Tshwane, South Africa, in July 2006. This school is known as "previously disadvantaged", a name given to poor government schools. The learners are from very poor backgrounds and most travel long distances from outlying rural areas on a daily basis to get school. At the time of the pilot, most learners did not own their own mobile phone, and some had never used a mobile phone before. However, within a very short period of time, they had discovered the FM radio on the phones and had tuned in to a local radio station. The "learners" (South African term for school "pupils" or "students") had no problem with using the technology during the pilot and reacted as positively to the lesson plan as learners from other, more "advantaged" schools. In an interview one young man said that what he liked most was playing games on the phone (he had never used a smart phone before and had never played a digital game). While this shows that, whatever their socio-economic circumstances, children feel comfortable with technology and intuitively explore and experiment with it, this does not necessarily mean they are well-equipped emotionally for responsible use of the technology.

Ironically, many parents buy mobile phones for their children as safety devices, so that they are reachable wherever they may be. As "Digital Immigrants" (Prensky, 2001) they are often unaware of the real reach of the mobile phone in the hands of their "Digital Native" children (Prensky, 2001). Children themselves are ill-prepared for the instant connectedness to the world that is made possible by these devices. Not only do they have access to instant messaging tools like MXit, but most of the latest phones also have full internet connectivity (once again, at a fraction of the cost). If this is linked to the fact that "traditional" internet penetration in South Africa (i.e. via networked computers) is only 5.1%, (Internet World Stats, 2007) it means that most of these children have had very little exposure to the digital world. Add to this the fact that many children in Africa come from poverty-stricken backgrounds, this indicates that they may well be rife for exploitation.

Another MobilED example may be cited here to demonstrate the vulnerability of these children. As part of the initiative, a mathematics mobile tutoring application was made available via MXit - "Dr Math on MXit". The service includes a group of volunteer tutors from a local university who are available from 14h00 to 20h00 every day. Learners from around the country are able to contact these tutors one a one-on-one basis using text-based interactions to ask mathematics-related questions. The learners are told to choose a nickname, which is used by the Dr Math software to hide their mobile phone numbers (normally the default mode is full disclosure of these numbers, already a risk factor). Although the interactions are kept strictly mathematics-related, many other issues began surfacing during interactions. There is a concerted effort by the learners to develop a more personal relationship with "Dr Math". For example, many report that they have done well in tests dues to the help from "Dr Math", looking for acknowledgement and emotional support. Many children also contact "Dr Math" just to say "Hi". There are also disturbing incidents where learners report potentially abusive situations in their personal lives. All tutors have the Childline Call Centre number available and have been trained to urge the children to contact this number. Every child, without fail has said they didn't want to phone this number. However, due to the increasing positive publicity of the "Dr Math" service, it seems that Childline will be offering a similar service in the near future. Other incidents include "Dr Math" being propositioned in various sexually explicit ways. Tutors have been trained to ignore this and to keep asking the question "Do you have a maths question for me?". All interactions are logged and the data is stored for further analysis.

Thus children step out as "Digital Citizens" without preparation, without having the normal role models, without understanding the rules, responsibilities or inherent dangers of this new world. Most times parents are either unaware of the issues, or when they do find out, often (understandably) react in extreme ways (such a removing or banning the devices). Prensky (2001), as quoted above, talks about the singularity that has taken place, where things have changed so fundamentally that there is no going back. These devices are here to stay, becoming more powerful in orders of magnitude and are already integrated into daily life. A solution may be to embrace the opportunities offered by this technology, rather than trying to suppress the use of mobile phones by banning them in schools (or for private use). This should not, however, be done naively, but with the understanding that there is a great deal that needs to be done to prepare the way. It is imperative that children (and communities) are equipped with the necessary skills to deal with this new world. It is a fallacy to assume that the life skills that are taught and that are developed from a young age can easily translate into the digital world.

There is an urgent need for a partnership between parents and teachers in order to ensure that children are taught "Digital Life Skills". In South Africa there is already a focus in the curriculum for developing life skills amongst learners, but there is currently no integration of the skills needed in the digital world into this curriculum. This is a matter that needs to be attended to before any major mobile learning intervention in a school or within a community, or even befor the "simple" act of buying a mobile phone for your child.

MOBIQUETTE

Prensky (2005) has once more stated very succinctly - "*Can cell phones really provide their owners with the knowledge, skills, behaviours, and attitudes that will help them succeed in their schools, their jobs, and their lives? I maintain that the only correct answer to the question of what students can learn with a cell phone is* anything, *if we educators design it right.*"

The various MobilED pilots in schools in South Africa have proved that mobile phones as learning tools have incredible potential in schools. However, the main obstruction seems to be educators themselves and to a lesser extent, the educational system.

Educators seem to recognise the potential, but are often unwilling to utilise the technology in the classroom. They cite the "nuisance" and "distraction" factors as the main reasons. In South Africa, a model of "outcomes-based" education was introduced into the schooling system as of 2005. This has been a major paradigm shift away from previous instruction-based pedagogical models to more collaborative constructivist approaches. Whilst the philosophy and the policy are in place, the practical implementation lags behind. Using a mobile phone as a learning device whether in or out of school, requires a good deal of rethinking and flexibility on the part of educators (Prensky, 2005). It requires, for example, the transformation of the educator from a gatekeeper to a facilitator and a loss of "control". However, given the opportunity, learners are sure to embrace, use, and make the tool their own in various unexpected ways—just as they have been doing with all useful digital technology (Prensky, 2005).

There is thus a need to "institutionalise" mobile phones in schools, not just as tools for learning, but in various other practical ways. It has become clear, for example, that children need to be schooled in the concept of mobile etiquette or "mobiquette". Ironically, the intrusiveness of mobile phones is not confined to schools, but are a problem in many boardrooms across the world as well (Agre, 2001).

One of the schools participating in the MobilED pilots is Cornwall Hill College, a private school in Tshwane, Pretoria. The learners at the school are from a wealthy community and have access to information and communications technology (ICT) and are fully computer-literate. The school has a reputation for innovation and for being forward-thinking. However, the MobilED team initially also met with some skepticism from educators at the school. After the first pilot, the word seemed to spread and the school now prides itself on its proactive and transparent approach in integrating mobile phones into daily teaching practice. The photograph (Figure 2) below illustrates the use of mobile phones in recording interesting educational events. It shows learners recording a dissection in a biology class.

Figure 7. Recording a dissection

The school has developed a "practise-based model" for the introduction of mobile phones for teaching, learning and administration as illustrated in Figure 3 below .

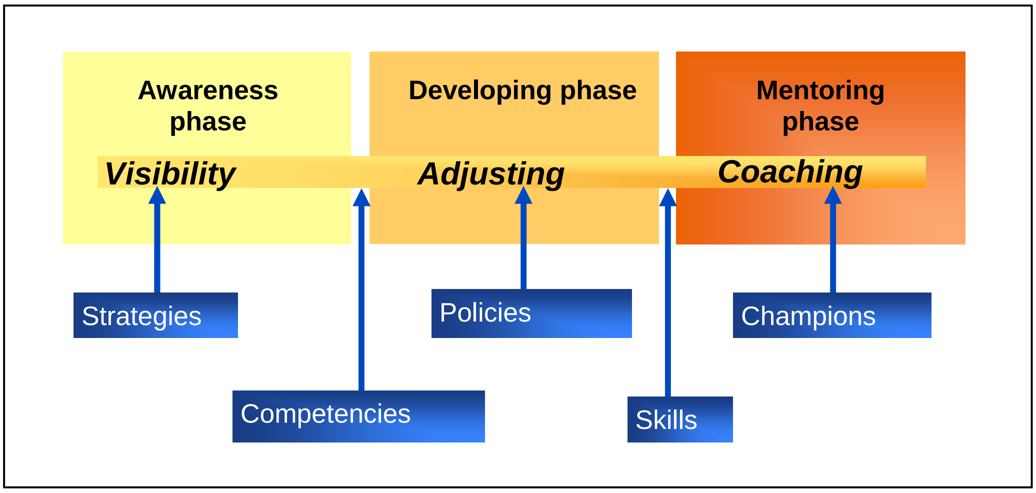

Figure 8. Practice-based Model for the introduction of mobile phones (Batchelor, 2007)

If we focus on the "Policies" aspect of this model, it is interesting to note that, although they do have an acceptable use policy which covers the use of technology in the school, the focus is more on a "values-based" approach, rather than a "rules-based" approach within the school. For example, they have an anti-bullying policy, which covers all aspects of bullying, including cyber-bullying. They also have a policy of "Respect for fellow pupils and teachers" and interviews with the teachers have indicated that they very seldom have issues with ringing mobile phones in assembly, for example. Cornwall Hill College has acknowledged that its role of gatekeeper to technology and information, to large extent, has fallen away and has approached the integration of technology from their values -based education approach.

This may be an extreme case of a reasonably sophisticated school environment and this approach may not work in other settings. The recommendation is that if a school wishes to incorporate mobile phones into the teaching, learning and administration processes, a detailed "Acceptable Use Policy" regarding mobile phones be set up. This document should spell out the "mobiquette" expectations within the school, applying to both educators and learners equally. It is important that all role-players be involved in the setting up of such a document – this includes school management, parents, educators, the IT department and, most importantly, the learners themselves. Examples of possible statements in the policy are given below:

- *Virtual identities that are embedded in any mobile technology and accessed by any means are expected to conform to acceptable naming standards.*
- *Mobile phones or other mobile technology should never be used to take photos in change rooms, toilets or in any situation that may cause embarrassment or discomfort to their fellow students, staff or visitors to the college.*
- *If not directly used in educational practices in class, students may access the music function or audio visual functionality of mobile technology only during breaks or after school.*

This policy document does not only pertain to learners but to staff as well, as use and integration of this kind of technology is as much unchartered ground for staff as for learners.

CONCLUSIONS

Engineering the integration of mobile technology in general and in developing scenarios especially, requires sensitivity to more than just the technical aspects of such an intervention. The extended activity theory provides a lens through which the practitioner can understand the factors that impact the integration of technology in a society. In the absence of historical cultural norms and guidelines as with most new technologies, it is necessary for research initiatives to consider incorporating structures for the responsible use of the technology as much as to pilot the technology. These values, norms and protocols are best established from within the community than suggested from outside by linking it to established practices. At best it suggests discussions with fast ethical considerations. This paper reflected on the lessons learned from the MobilED initiative and it is hoped that it will facilitate an awareness of issues indirectly associated with Mobile Learning development initiatives and the sustainable implementation of these. It is important that a radical innovation such as the integration of mobile phone technology and services into the school environment supports various "best practises". This will ensure that the innovation has the most chance of ongoing success in ways are that are sustainable, acceptable, protect the learners and ensure that the school is fully prepared.

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Improving Cross-cultural Awareness and Communication through Mobile Technologies

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ABSTRACT
Increasingly, technology is mediating the way that youth around the world communicate, and consume and create content. As mobile communication media and the internet become more pervasive, young people are afforded more opportunities for collaboration across distances and communities from different cultures. The need for cross-cultural awareness and communication is thus more important than ever. The project described in this paper successfully demonstrated the role of mobile phones and the web as mediating technologies in the development of intercultural competencies and intercultural communication skills among a group of teenagers, distributed across two countries.

Author Keywords
Mobile storytelling, intercultural communication, intercultural competencies, online collaboration, digital media

BACKGROUND
From August to December 2007, ten teenagers aged 12 to 14 were invited to document culturally relevant aspects of their lives and their communities, publish the material online and to engage each other around that content. The participants, five teenagers from the United States of America (USA) and five from South Africa (SA), represented diverse backgrounds and realities. At their disposal the participants had smart phones to document the world through their eyes. The stories they captured were published online as digital artefacts accessible to all of the participating members of the project. An aim of the project was to see if the mobile stories created would reflect these diverse perspectives and ultimately lead to increased cross-cultural awareness between the participants.

The project described in this paper successfully demonstrated the role of mobile phones and the web as mediating technologies in the development of intercultural competencies and intercultural communication skills among a group of teenagers, distributed across two countries. Efforts were co-ordinated by researchers at Stanford University (USA) and the Meraka Institute, Council for Scientific and Industrial Research (SA).

THEORY
Increasingly, technology is mediating the way that youth around the world communicate, and consume and create content. Central to the lives of many teenagers in the USA is the use of social media such as blogs and social networking sites. According to a Pew Internet study, 93% of US teens ages 12-17 use the internet and more of them than ever are treating it as a venue for social interaction – a place where they can share creations, tell stories, and interact with others (Lenhart et al., 2007). The study revealed that 39% of online teens also share their own artistic creations online, such as artwork, photos, stories or videos; 28% have created their own blog; and 55% have created a profile on a social networking site such as MySpace or Facebook.

The national school study *Speak Up 2007* revealed that over half (52%) of learners in grades 6-8 and two-thirds (67%) of those in grades 9-12 had access to a mobile phone (Project Tomorrow, 2008). The study concluded that amongst school learners in the USA, access to mobile devices (mobile phones, MP3 players, personal digital assistants and smart phones) has exploded in the last year. Learners were apparently very interested in making better use of these devices for learning and particularly to assist with communications, collaborations, creativity and productivity.

The same depth of figures does not exist for SA. What is known is that in 2006 the number of all internet users (not just teenagers) was around 10.8% (International Telecommunication Union, 2007). While access to computers is relatively low, 68% of the population had access to a mobile phone in 2006 (Gilwald, 2008). A very popular mobile instant messaging (MIM) service used by many youth in SA is called *MXit*. Currently there are around over 6.5 million MXit subscribers in the country, sending 200 million messages per day (Computing SA, 2008). While not the largest age group in the subscriber base, the under-18s are the most active (Vanek, 2008).

One of the very few studies conducted on the mobile usage of teens in SA found that most teens aged 13-16 were very dependent on their mobile phones for communication and social status (Oelofse, De Jager and Ford, 2006). The authors of the study described the uptake and use of mobile phones by teens in SA as a "social revolution."

MIT professor, Henry Jenkins, (2006, p. 290) defines 'participatory culture' as a culture in which "consumers are invited to actively participate in the creation and circulation of new content." Certainly a large percentage of technology-enabled youth around the world live out the dual producer/consumer role in a participatory culture. While much youth content that is created, shared and consumed is of a highly frivolous nature – one only has to spend some time on YouTube or MySpace to see this – there are also many cases of more substantial and XYZ content initiatives. For example, the Listen Up Youth Media Network (http://www.listenup.org), the International Visual Methodologies Project (http://www.ivmproject.ca) as well as the Centre for Digital Storytelling (http://www.storycenter.org) have facilitated young people in the role of digital media producers for purposes of education, social change or artistic expression. Youth working with these organisations have demonstrated the ability to candidly and critically reflect on personal and societal issues affecting their life experiences (Mitchell et al., 2006). When taking on this role in a creative capacity, the young participants become "cultural producers." It is to them that the following quote applies:

> *Changes in access to technology have facilitated new conditions for young people to shoot, cut, and mix multimodal texts, and the emergence of the Internet as "home theatre" for a global audience has enabled youth to communicate across borders and across the street. These new conditions have allowed for an outpouring of youth expression, a channeling of latent youth voice...* (Hoechsmann and Sefton-Green, 2006)

Technology-mediated collaborations between globally-distributed youth are also increasing. For example, through the International Education and Resource Network (iEARN), more than one million learners from 120 countries collaborate on projects every day (iEARN, n.d.). These youngsters use digital media to take on the role of cultural producers.

But while teens "embrace the conversational nature of interactive online media" (Lenhart et al., 2007) and increasingly enjoy greater collaboration across communities and borders, the enabling technological advances do not necessarily equip them with the necessary skills to negotiate the cultural differences between disparate groups.

Jenkins et. al. (2006) identify negotiation – the "ability to travel across diverse communities, discerning and respecting multiple perspectives, and grasping and following alternative norms" – as one of the new media literacies that young people need today. Negotiation is essential because in the new media environment, "culture flows easily from one community to another" and people online "constantly encounter conflicting values and assumptions."

> *Everything about this process ensures that we will be provoked by cultural difference. Little about this process ensures that we will develop an understanding of the contexts within which these different cultural communities operate.* (Jenkins et. al., 2006)

The key is to "understand the way in which others located in different global contexts perceive, analyse, and produce situated knowledge" (O'Brien, Alfano1 and Magnusson, 2007). Within the field of intercultural theory, this skill is called intercultural competence and sensitivity (Lovitt and Goswami, 1999). Intercultural communication represents the successful negotiation across diverse cultural contexts because of a high degree of intercultural competence.

In a world where the production and distribution of cultural artefacts is increasing, as is collaboration across different cultures, it is not surprising that Samovar, Porter and McDaniel (2005) argue that "successful intercultural communication is a matter of highest importance if humankind and society are to survive."

METHOD

While in the past two decades there has been a surge of interest in globalisation and intercultural communication, a key problem remains: "how best to use information and communication technologies (or ICTs) to offer students hands-on learning of transnational and intercultural differences" (O'Brien, Alfano1 and Magnusson, 2007). To practically explore this problem, researchers from Stanford and Örebro Universities initiated the *Developing Intercultural Competencies through Collaborative Rhetoric* project. This involved teaming globally-distributed students (in the USA and Sweden) to analyse rhetorical artefacts (e.g. speeches, advertisements, architectural landmarks and representations of nationhood) with the aim of improving the intercultural competencies and intercultural communication skills of the participants. For collaboration the students used video conferencing, MSNchat, Skype, Google Docs, blogs, wikis and email.

In the context of the Stanford/Örebro project, we undertook to explore the development of intercultural competencies and communication skills of geographically disparate teenagers using mobile phones and the web as mediating technologies. One of the key measures of intercultural competence – and one used in the Stanford/Örebro project – is "sensitivity to and consideration for others" (Lovitt and Goswami, 1999). Thus in our project we wanted to explore the role of mobile and web technology in mediating and enabling the development of a greater sensitivity and consideration amongst the teenage participants.

From the outset, this was not a formal research project; rather it was a hands-on and informal pilot to "see what happened" as the young participants created and collaborated with each other as cultural producers and negotiators. To surface any changes in the desired competence and skills, we held regular discussions with the participants throughout the project, as well as exit focus group discussions (one in the US and one in SA). The qualitative data gathered during these discussions complimented the actual content produced by the participants and online interactions between them on the blog site.

PROJECT DESCRIPTION

The Bay Area Video Coalition (BAVC) in San Francisco runs an annual summer internship program for high school learners that have completed a course in video production at BAVC. As part of their internship last year, a group of teens needed to complete an individual and collective media production project. Steve Vosloo (a South Africa) and John Kuner, both research fellows at Stanford University, were volunteer supervisors to the group. They made contact with the MobilED initiative in SA to discuss the possibility of an international collaborative project between the five BAVC interns and youth in SA. Adele Botha, a researcher at MobilED and the Head of IT at a high school in Pretoria, agreed to facilitate a group of five teens in SA. The plan was for the participants to use their mobile phones and the web to document, reflect upon and share some aspects of their personal and community life experiences – based on prompts given to them – that reveal something about their culture.

When contrasted with school-based projects, youth media organisations – such as BAVC – "stand out as innovatory sites of the new cultures of youth media production" (Sefton-Green, 2006). We wanted to capitalise on the affordances of an informal media project to explore any changes in cross-cultural awareness experienced by the two groups of teens, who came from different social, economic and ethnic backgrounds. We hoped that the process of discussing, planning and creating each publishable piece would force the teens to think about the effects of culture in their own lives and how to portray that to others living in a totally unfamiliar place.

It is useful to consider the digital media creation, distribution and consumption process as storytelling in a shared space. Joe Lambert, an expert in digital storytelling, reflects that in the storytelling process a variety of perspectives and meanings are presented (Lambert *et al.*, 2007).Each person articulates his or her views in through stories that try to be compelling and yet accessible. When conducted in a shared space, others are invited to reciprocate. The space in which stories are shared and collaborate around becomes an entity with a life of its own. The participants place their own lives under the microscope and seek out the bits that others might find interesting. In order to self reflect, a step back from reality is required so that the storyteller becomes a participant observer, objectively selecting and reporting on incidents, issues and areas of interest.

In this context we asked the teens to create multimedia vignettes, or mobile stories, that could incorporate still images, text and/or video. The project spanned two media: the camera phones were used to capture visual content, and the web was used for presentation and communication around that content.

In Vox (http://www.vox.com), a free hosted blogging service, a private group was created for the project, which acted as the online nexus for all of the blogging activity. Each participant created his or her own blog account to post their stories, links and images. While all participants were invited as members into the single, private group for the project, their own blogs could be publicly accessible.

On a weekly basis the participants in San Francisco met to discuss a new task, based on a series of themed prompts, e.g. tell us about the food you eat. The teens would sometimes conduct research online, shoot material at home or in their community, edit the content on a computer and then upload to the web as a post to their own project blog. The San Franciscans used Final Cut Pro for movie editing.

The broad themes for the self-documentation were: about me (where I come from; the story of my name; my favourite books, bands, things; the food I eat; my room, etc.); my family and community (my family's religious beliefs, historical background, rules in our household, what my community looks like and what I like about it); and a relevant issue in my community. We asked them to think about their own culture as a context for the project, to try to frame their lives, communities and issues within their particular cultural milieu. "Mobiquette" – acceptable mobile etiquette when using camera phones – was also discussed beforehand with the participants.

The South African group all attend Cornwall Hill College, a forward thinking and dynamic secondary school in Irene, Pretoria. It is common practice in this institution to use personal mobile phones in the classroom for learning and learning support. These learners preferred to communicate via short message service (SMS) and MIM to communicate tasks, prompts and provide support. Many of them preferred to upload content directly from their mobile phones, editing and contextualizing their contributions on-the-fly.

CONTRIBUTION

With the differences in school calendars, not all of the themed tasks were completed by both groups. Below is a selection of participant creations, starting with the teens from San Francisco. Much more can be learned about each participant from his or her project blog, if publicly available.

Bob* grew up in the Haight Ashbury neighbourhood of San Francisco, the epicentre of the sixties hippie movement. He is a big fan of graffiti as a form of street art, which comes through in his neighbourhood video[1], appropriately set to a song by a busker on Haight Street, recorded with his mobile phone.

Figure 1: Shop window

Figure 2: The Red Victorian in San Francisco

Luisa* lives in the Mission District of San Francisco, a traditionally Hispanic community with beautiful, colourful wall murals that reflect the history, transition, pain and hopes of its immigrant community. Her neighbourhood video[2] captures some of this cultural heritage and portrays the vibrancy of the shops and people living there. She is Mexican American, named after a saint. In the video of her room,[3] filmed by herself with her camera phone, she shows us her Rosary Beads, favourite videos and music. It is a brief but intimate peak into the life of a Mexican American teenager living in a neighbourhood in San Francisco that is specific to a particular culture with a particular history.

San Francisco is home to many different cultures. It is a city known for its food – from all over the world – and it's liberal attitudes to politics, sexuality and diversity. Kim*, whose family moved from Vietnam to the USA when she was three, highlights the culture-destroying influence of American fast-food. She is interviewed by one of the other teens in the project as she sits down to lunch that she bought from Starbucks. In the short video she explains how the only thing the meal represents is convenience and that she knows nothing about the person who made the sandwich. Against the backdrop of San Francisco's diverse food culture, her view contrasts the facelessness of commercial, corporate America. The blog post about her[4] that includes a video tour of her room tells us more – explicitly and implicitly – about the cultural worlds that she occupies, both Vietnamese and also being a typical US teen. Her video[5] of the Excelsior neighbourhood shows how many different ethnic groups – e.g. Japanese and Italian – share this space.

Before heading out “into the field” Jonathan* talks[6] about the plan to film his neighbourhood.[7] While he was born in San Francisco, his mother is from the Philippines and father from El Salvador, as described in his introductory post.[8]

For the “issue in your community” prompt, the San Franciscans decided to work as a group on homelessness, which they saw as a problem in the city. They first discussed the issue amongst themselves in person, conducted desktop research, compiled interview questions, and then headed out to take photos and conduct interviews. Bob's series of photos[9] and Luisa's photos[10] and video interview[11] with the Coalition on Homelessness provide a good insight into the issue and clearly reflect a high degree of criticality in the way that both teens portray this social issue.

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1 http://ozark71.vox.com/library/post/my-movie-on-the-haight-ashbury-neighborhood-of-san-francisco.html

2 http://lupe543.vox.com/library/post/la-mission-in-portuguese.html

3 http://lupe543.vox.com/library/video/6a00d4144d4eb83c7f00e398a03f540001.html

4 http://diemmvo.vox.com/library/post/about-me.html

5 http://diemmvo.vox.com/library/video/6a00d41448d19f6a4700e3989bddaa0004.html

6 http://honu824.vox.com/library/post/shooting-plan.html

7 http://honu824.vox.com/library/post/honu824---wed-jul-25-162930-2007.html

8 http://honu824.vox.com

9 http://ozark71.vox.com/library/post/homeless-photos.html

10 http://lupe543.vox.com/library/post/homeless.html

Turning to SA, Phil*, who hails from the rural town of Mafeking, documented his experiences of moving to Johannesburg, SA's largest city. On his blog he kept a detailed journal of day-to-day life in this vibrant city.

Brad* is a 'techie' and a ‘tree hugger’. In one of his blog posts that includes images and video he shouts out to the international community of liberal environmentalists and informs them of the conditions in SA.

Figure 3: Building up a computer

Figure 4: The door to Artemis's room

Artemis* is of Greek-Norwegian descent. He is “into the culinary arts” and enjoys experimenting with the various flavours of the African continent. His menagerie at home includes a pet parrot,[12] tropical fish and a number of four-legged animals. He posts on his colourful home life and describes his younger sister and the baby being fostered by the family. A visit to a flea market[13] in Johannesburg is a reflection of the cultural diversity of SA's “rainbow nation”.

Instead of writing about what he did with his free time, Shaun* (15) used his phone to make a video.[14] His posts describe his family history, a love for PlayStation games and the family pastime of breeding pedigree Chow dogs.

Ethan’s* postings portray him as a sport fan. He supports the local “Blue Bulls” rugby team and himself play rugby aand swims at school. He loves reading and going to the family’s game farm. Elephants were recently released and he shares the majesty of these animals with the others. He also illustrates the skill of skinning a springbok. A video and several pictures have been added of the game farm and of the antelope and bird his cousins shot.

While the American teenagers were more into hip hop and graffiti – reflecting their urban environment – the South Africans enjoyed a variety of activities including heavy metal, fantasy books, barbecuing (or “braaing”) and hunting. As Phil commented: “[I love] a good piece of meat, just the right spicing and a little pink on the inside is perfect!” Computer and video gaming was also very popular. Phil goes on to say: “I am very into anything and everything electronic or computer related since I was about 9, the way everything just meshes together is just fascinating. Take the current state of computer graphics ... it's becoming so real that it's blurring the lines of reality.”

While much of the material was fairly high-level, e.g. “I can't survive without my iPod,” or photos of pets, there were also instances of personal disclosure. For example, one girl described her resentment towards the US government because it had “abandoned” her father who supported the American troops during the Vietnam war. As a result of this he spent 13 years in a re-education camp in Vietnam before managing to move to the US. Or a boy's pain as he dealt with his parents' divorce, even though they continued to live in the same house (“in different rooms, of course!”) All of the personal moments, not necessarily deep or painful, are endearing and alive with teenage honesty. These are the essence of the project, and only began to appear when a certain degree of trust had developed in the shared space.

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11 http://lupe543.vox.com/library/post/interview.html

12 http://archmageofethrealfire.vox.com/library/post/crazy-is-as-crazy-does.html

13 http://huggybear56.vox.com/library/photo/6a00d4144905b6685e00e398a689070005.html

14 http://hobgoblin.vox.com/library/post/my-free-time.html

PROJECT REFLECTION

Lack of immediacy did not affect the group collaboration at all. The time difference between the USA and SA made online chat or voice conversation impractical, although both groups wanted to engage in this.

Of significant interest was the readiness of the participants to publish their stories. They could each determine the privacy level of their blogs, making it viewable only to the group or to publish publicly. Most of them chose to go public, although some did blog under a pseudonym.

EVALUATION

Did the participants develop their intercultural competencies through the project? We believe they did. During the focus group discussions after the project had officially ended, the participants in both groups reported that they had learned a great deal about each others' lives and also about their own.

While differences between the groups were noted and discussed it was really the high-level of similarities that was obvious to everyone. Jonathan said: "I learned how our cultures [US and South African] contrast, and also how they're similar. I think that was my favourite part." About the South Africans, one US teen struggled for the right word and then said: "They were more 'civilized' than I expected. Their interests are European and Westernised." The group in SA echoed these sentiments with one of them remarking: "The world is actually very small; I suppose we could all have been friends in another time or place. You know they are just like us." These comments convey a definite sensitivity towards and understanding of others on a cultural level, a measure of intercultural competence. Further, the South Africans were mindful to explain local slang and the meaning of Afrikaans words when these were used, again reflecting an inclusive approach.

The prompts encouraged the teens to think about many of the things they considered as taken for granted. Things they like, don't like, eat, watch, say and do. The two groups of teens stated that when documenting their own lives, they realized how much they were influenced by the diversity surrounding them. Be it from traditional family values, the community, peers and simply the times – living as fourteen year olds in San Francisco or Pretoria in 2007. A common theme was how they were proud of their heritage. Bob reflected that: "I think it's important to show the many sides of San Francisco to the kids in South Africa because it is a place so full of culture and life."

The project required a high degree of self-reflection, communication of views and life situations across differing cultural contexts and, because of comments and responses being traded, a level of cross-cultural negotiation. The photos, videos, text pieces and comments all attest to the participants' successfully meeting the project's requirements. In this sense we believe that their intercultural communication skills did improve.

What did the participants think about using mobile phones to document and reflect on their lives? "The camera phones were cool, different," responded one the US girls. One of the other girls said that she would never have considered using camera phones as a way to educate and influence others. Once the project began the participants were all completely comfortable with using mobile phones as capture devices for the visual projection of themselves and their communities. They did, however, comment that lighting and sound were issues when using camera phones.

Due to budget constraints, the San Francisco teenagers could not upload content directly from their phones to the website. This was a pity as the immediacy of mobile phone communication proved to be one of its greatest features with the Pretoria group. A photo of graffiti, taken while walking home from school, uploaded immediately is highly contextualized and relevant, and appeals to youth expectations of instant gratification.

We initially sought to explore the role that mobile phones and the web would play as mediating devices and technologies in this process. The mobile phones, whether used only as camera phones, or as both camera and communications devices (including immediately blogging and uploading media), proved to be very suitable devices for the creation and sharing of digital cultural artefacts. Because mobile phones are so pervasive, and have become such an everyday device, they are always on hand. This makes them very well suited to "capture the moment", which is often when cultural nuances are revealed. The blogging interface, suited to the persistent publishing of photos, stories and videos and asynchronous communication and collaboration, successfully complimented and supported the phone activities from in-the-field.

Using mobile phones, so much a signifier of youth identity today, certainly contributed to the intimate nature of the stories that were told, enabling the teens to reflect through a medium they were comfortable and proficient with. No training was needed for mobile phone usage. The technologies used enabled – rather than hindered – collaborative reflection.

CONCLUSION

While more action than formal research, the project helped us to understand the possibilities, challenges and limitations of using mobile phones and the web in international collaborative projects. The shared online space encouraged frank and open contributions in a trusted environment. The cultural productions functioned not only to represent individual perspectives but also to engage and challenge other members of the project community. The process of creation, sharing and negotiation provided an opportunity for participants to foster relationships and to contextualize their lives to create shared understandings. Through technology-mediated cultural production and negotiation, the participants thus successfully demonstrated their development of intercultural competencies and intercultural communication skills.

As with the Stanford/Örebro project, we regard "find the use of technologically-mediated collaboration to be an influential tool with regard to social relationships and improved cross-cultural understanding." (O'Brien, Alfano1 and Magnusson, 2007). In spite of the many differences between the two groups and amongst the groups themselves they found common ground. At the time of writing, some of the participants are still in touch with each other, with no prompting from the project facilitators.

More research is needed in this space. Technology is rapidly changing and influencing youth participation in cultural production and negotiation on a global level. "Our need to understand the relation between digital media and learning is urgent because of the scale and the speed of the changes that are afoot" (Ito et al., 2008) The role that mobile communication media can play in the development of cross-cultural awareness needs to be explored in formal educational and informal learning spaces. At the very least, we have shown that mobile phones have a place in the creation of meaningful user-generated content for improved cross-cultural awareness and communication. Certainly, as communication media devices, they have progressed "from text to context."

* Names have been changes to protect the participating minors

ACKNOWLEDGEMENT

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A Mobile Computer Supported Collaborative Learning Tool for Digital Narrative Production

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ABSTRACT

There is agreement that Digital Video Production (DVP) offers potential to support collaborative learning and encourage creativity, self-expression, and deeper thinking. This paper describes the design, architecture and implementation of a mobile computer supported collaborative tool, the Digital Narrative Tool (DNT). The tool provides integrated facilities that include a collaborative story script, shared storyboard, timeline-editor, and communication tools to support users to maintain a shared understanding during the creation of a digital narrative. The performance and functionality of the tool changes as users move from high performance PCs to mobile devices, replacing the rich graphical and communication support on PCs with alternative communications tools and simpler graphical user interfaces on mobile devices. It achieves this in a heterogeneous technical environment containing mobile phones, PCs, and differing networking technologies by using the Mobile Unified Storytelling Environment (MUSE) a reliable platform for creating mobile computer supported collaborative applications. The evaluation of the DNT tool presented here is in relation to its functional characteristics.

Author Keywords

Mobile learning, Digital Narrative, CSCL, CSCW, Collaboration

BACKGROUND DOMAIN

Computer supported collaborative learning (CSCL) builds on the field of computer supported collaborative work (CSCW) and has principally concentrated on building collaborative learning applications, and devising best-practice guidelines, using desktop computers. An emergent area within CSCL is that of mobile CSCL or (MCSCL). MCSCL aims to leverage the affordances of mobile devices to create learning activities that differ from desktop-based CSCL. How best to do this is an open research issue but there is a growing consensus in the mobile learning community that applications informed by the principles of constructionism, constructivism, collaboration, and contextualization are of particular value for exploiting mobile devices for learning. This paper describes the design and implementation of a MCSCL application for digital narrative production called the *Digital Narrative Tool* (DNT). The DNT is an application built using the *Mobile Unified Storytelling Environment* (MUSE), an MCSCL system to support constructivist, constructionist, collaborative and contextualised learning applications. The MUSE system provides a reliable platform on which to build such applications using PCs and mobile devices.

There is a growing body of evidence in the literature that Digital Video Production (DVP) can facilitate powerful learning experiences (Buckingham, D. et al. 1999, Kearney, M. and Schuck, S. 2005, Reid, M. et al. 2002). Yet DVP is not without its problems. While the cost of digital video cameras continues to decrease, they remain a relatively expensive. More importantly, DVP is a time consuming activity with resulting issues relating to access and control (Burden, K. and Kuechel, T. 2004). Filming and editing, which offer the greatest learning benefits, involve time-consuming classroom management, making DVP somewhat impractical as a whole class activity leading to scheduling problems in the classroom (Arnedillo-Sánchez, I. and Tangney, B. 2006, Reid, M. et al. 2002). DVP is typically a sequential process involving planning, storyboarding, scripting, filming, and editing. Though all group members are involved in the early stages, filming and editing are a bottleneck with only some users participating and benefiting educationally at these stages of the process.

THE MOBILE DIGITAL NARRATIVE APPROACH (MOBILEDNA)

The mobileDNA (Arnedillo-Sánchez, I. 2008, Arnedillo-Sánchez, I. and Tangney, B. 2006) is a pedagogical methodology specifically designed to scaffold collaborative creativity among distributed learners engaged in the creation of digital narratives with mobile technologies. Although it is informed by traditional DVP approaches, it distinctly differs from these in that the mobileDNA short-circuits the planning, scripting, and storyboarding stages and parallelises shooting and editing (Figure 9). Thus, it enables the synchronous participation of an entire group of learners in all phases of the production and lowers the time demands. At the heart of the mobileDNA methodology there is a three-phase task-oriented digital narrative creation activity involving *Story Generation*, *Shooting and Editing*, and *Production and Screening*.

During the *Story Generation* the participants, collaboratively and face-to-face, create the story to be told. When *Shooting and Editing*, they are divided into three groups: the *Image Group*, who shoot the visuals and play the parts; the *Sound Group*, who record the audio (dialogues, narrations, sound effects, etc); and the *Editing Group*, in charge of assembling the media created by the other two groups. A peculiarity of this phase is that the Image and Sound groups separately go on location to shoot the story while the Editing group stays in the Editing Station. As the media is being captured with mobile phones this is transferred via Multimedia Messaging Service (MMS) to the editors who can start editing shortly after the Image and Sound groups have arrived on location and started shooting and recording. By the time the crew and cast are back at the Editing Station, the first version of the digital narrative is ready for viewing. During the *Production and Screening* phase, the participants review the digital narrative in the making and engage in a critical evaluation of their work, which may lead to additional cycles of targeted shooting and recording. Editing continues until the group is satisfied with their digital narrative and this is ready for screening.

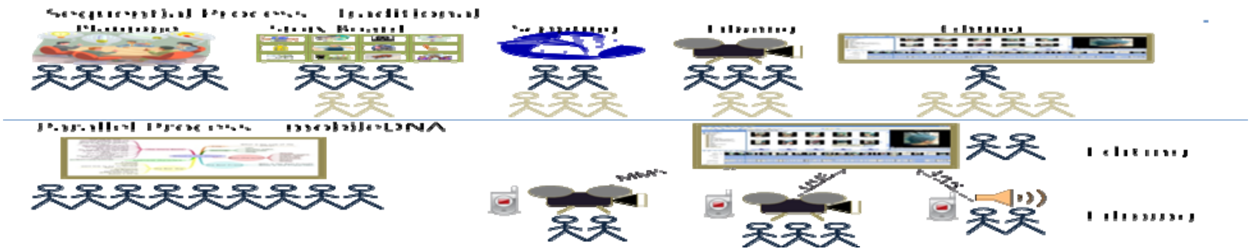

Figure 9: Sequential vs. Parallel Process

In order to implement and evaluate the mobileDNA and its three-phase digital narrative creation activity, a prototype of the DNT was developed by combining several pieces of proprietary software. These include: a Scripting Tool (developed with a concept-mapping application) that scaffolds the story generation, and outputs a paper-print of the story script; an MMS gateway to transfer files from the mobile devices to the computer; a PC operating system to manage the media files; a video editing application to edit the movie; and the native interfaces on the mobile devices for media capture.

DIFFICULTIES ENCOUNTERED WITH THE MOBILEDNA

To date, 200 people have participated in the mobileDNA workshop and successfully created collective digital narratives using the DNT prototype (Arnedillo-Sánchez, I. 2008, Arnedillo-Sánchez, I. and Tangney, B. 2006). The evaluation of the methodology and the participants' experience is outside the scope of this paper. However, findings from multiple case studies clearly indicate that the data and workflow underlying the digital narrative creation activity and the DNT prototype efficiently support the emergence of productive collaborative creative interactions among participants. Notwithstanding the previous, the lack of integration among the various tools that make up the DNT prototype present difficulties for the users. These include: maintaining a shared understanding between the filming and editing groups; managing media files; communication between groups; and scaffolding the process. The following paragraphs further describe the findings reported by Arnedillo-Sánchez (ibid).

Maintaining a shared understanding is a problem in all collaborative activities. During the first phase of the mobileDNA activity, the users create a story script with the Scripting Tool. To compensate for the lack of explicit connection between the application used to create the story script and the native interfaces of the mobile phones used to capture the media, the participants carry with them on location a paper-print of the script. However, this is not ideal in practice and leads to lack of a shared understanding between the filming and editing groups. Such misunderstandings largely occur between the story generation and shooting, and between shooting and editing.

As part of their task, the Image and Sound groups create visuals and sounds that they consider will contribute to the digital narrative creation. These groups often shoot and record scenes taking advantage of what is available in their surroundings and hence, not necessarily in the same order as in the script. Additionally, the filming groups may create several media pieces together and send them to the editor in a batch process later. The implication of this is that the editing group does not receive media in timeline order and can receive multiple similar media assets for the same scene. Consequently, the editors must attempt to assemble the media into a digital narrative without the context and access to the original reason or motivation for capturing a piece of media.

Conversely, there is little feedback from the editors to the filming groups so users capturing media are unaware of the progress of the overall digital narrative with the result that they often do not capture enough images for a scene. As the filming groups use MMS in a one-way fashion to send media to the editors, the editors must wait until the filming groups return to the base location to inform them of this dearth of images. Providing this feedback involves conscious effort by the editors to inform the filming groups of the lack of images. Another factor related to a lack of shared understanding is the difficulties with file management experienced by editors, as they cannot directly relate media files received from the filming groups with the story script. For instance, without additional information it is impossible to judge what a sound file contains before actually listening to it.

In review, DVP is an established activity for learning that would benefit from greater support for collaboration. The mobileDNA advocates a parallel approach to filming and editing, so aiming to increase user participation and engagement throughout the process while promoting greater collaboration between the users. The mobileDNA uses MMS on the mobile phone to provide additional support for collaboration in the filming and editing stages. The next section describes the implementation of the integrated DNT application. This is informed on the DNT prototype (Arnedillo-Sanchez, 2008), additional data and workflow requirements distilled from the evaluation of the mobileDNA workshops, and user interface features suggested by research into CSCW and CSCL. The section after next outlines the overall architecture of the MUSE system on which the DNT is developed. The description of the functional evaluation of the DNT follows this section. The paper concludes by putting forward a summary and indicating future direction of the research.

THEORY AND DESIGN CONSIDERATIONS

The focus of this paper is an MCSCL tool for digital narrative production, called the DNT, and in particular asks the question, is it possible to build such a tool to support digital narrative activities? To this end, the relevant theoretical literature will address: related work using MCSCL; the pedagogical underpinnings concerning mobile learning applications; and CSCW and CSCL research that informs the development of distributed environments and the communication and awareness mechanisms of the user interface of the DNT application.

The adoption of mobile devices with sufficient processing power to make useful applications feasible is increasing. MCSCL is an emerging area of CSCL that aims to use such mobile devices for collaboration and learning. There have been some previous attempts to use MCSCL to bridge the gap between users on PCs and mobile devices. For instance, MoULe (Arrigo, M. et al. 2007) is a Mobile and Ubiquitous Learning system, which enables users edit and share location based documents, concept-maps and wiki pages using PCs and mobile phones with GPS and built-in cameras. In addition, the system includes a learning management system so that users can access these documents online using moodle software. Another relevant study (Hwang, W.-Y. et al. 2007) describes an application called “StudentPartner”, an integrated multimedia forum, which allows users to capture media files with a mobile device and upload them to a shared database that users access through PCs and mobile devices, to create a shared discussion forum.

There is no single overarching theory of mobile learning, however several taxonomies have been put forward for classifying, and developing, mobile learning applications, most notably by (Roschelle, J. 2003) and (Naismith, L. et al. 2004). The functional-pedagogical framework for mobile learning proposed by Patten et al. suggests the best examples of mobile technology for learning are informed by collaborative, contextual, constructivist and constructionist learning theories (Patten, B. et al. 2006). The design of the DNT follows the latter taxonomy.

The purpose of the DNT is to seamless support the collective digital narrative creation process at the heart of the mobileDNA. Thus, to engineer the integration and automation of the work and dataflow underlying the DNT prototype and to further enrich the user experience by providing additional functionality. Much of the previous work on collaboration derives from the CSCW and related CSCL fields. Roschelle and Teasley stress the role of shared understanding in CSCL and describe collaboration as “a continued attempt to construct and maintain a shared conception of a problem" (p. 235) (Roschelle, J. and Teasley, S.D. 1995). Recognized solutions to this problem involve using shared workspaces and awareness mechanisms in the user-interface.

A shared workspace is a distributed environment in which all the users can interact with the workspace, the artefacts in the workspace, and each other, as if inside a single interface. This is a mature concept in CSCW with numerous implementations in this area over the last fifteen years, e.g. (Dourish, P. and Bellotti, V. 1992, Gutwin, C. and Greenberg, S. 1998). In addition, Rochelle et al. identified *division of labour* as a key strategy for collaboration, for instance, “students may choose to divide up multiple representations among multiple devices, to provide a larger overall screen space” (p. 58) (Roschelle, J. and Pea, R. 2002). While the *relaxed-What You See Is What I See* (WYSIWIS) approach sacrifices some awareness of the shared context, it allows better individual control (Gutwin, C. et al. 1996) so supporting division of labour and introducing flexibility in the collaboration methods adopted by the users.

A conventional approach to improving the user experience with a shared workspace is to include awareness mechanisms in the interface. The accepted definition of awareness is “an understanding of the activities of others, which provides a context for your own activity” (Dourish, P. and Bellotti, V. 1992). Awareness mechanisms considered in this paper include: *feed-through* (Gutwin, C. and Greenberg, S. 1998) as a carrier of implicit awareness information; workspace support for communication that relies on spatial information; radar views; embodiment in the workspace through colour and status information; awareness of past actions or interaction history; and communications facilities. The following paragraphs provide some examples of each of these awareness mechanisms in turn.

Implicitly as users interact with the shared workspace, they inform others of their actions by changing the state of that workspace, this information serves as the carrier of feed-through awareness information. GroupKit (Roseman, M. and Greenberg, S. 1992), which is a toolkit for building groupware applications, includes an example of a shared workspace that provides this feed-through awareness.

Consistent representation of spatial information is necessary to enable users refer to features of the workspace meaningfully in communication. Therefore, users need to know the workspace they are working in, and recognize spatial features of that space, e.g. size and the current state of the users and objects in the system (Yang, H. and Olson, G., M. 2002). Yet, in a relaxed-WYSIWIS system, a user cannot assume that all users are looking at the same portion of the workspace. One solution to allow users to maintain workspace awareness is to use a radar or miniature view (Gutwin, C. et al. 1996). Radars provide a user with information about what portion of the workspace the other users are observing. A key piece of awareness information that users need is concerned with who did what action. User interfaces should display information about what actions each user performs at any given time. Embodiment is a way to show users in a workspace and is how "users are themselves directly represented within the display space" (Benford, S. and Fahl, L.E. 1994). A typical source of embodiment information is to colour code all actions by the user who committed the action. To allow users to identify when an action occurred is important, Gutwin et al. call this *awareness of the past* (Gutwin, C. and Greenberg, S. 2002), and list presence history, location history and action history as the three elements of awareness of the past. Beaudouin-Lafon et al. attempt to convey this information using an *Echo* system, which highlights a user's actions by replaying the action, accompanied with an appropriate animation, in the other users' interfaces (Beaudouin-Lafon, M. and Karsenty, A. 1992).

Finally, studies of CSCW (Churchill, E.F. et al. 2000, Ellis, C.A. et al. 1991) note it is useful to support some form of informal communication to clarify issues and help avoid conflict. (Churchill, E.F. et al. 2000) recommend embedding instant messaging systems with the context of the objects under discussion, advising that a chat client should be included directly into the application and not in a separate window. In addition, Scholl et al. note that "chat will not become obsolete as audio/video becomes more widely available" (Scholl, J. et al. 2006).

In summary, one goal of the DNT is to help users to create digital narratives using images and sound collaboratively. A digital narrative is equivalent to a shared document in the CSCW sense, so lessons learned from this field are applicable to designing the DNT. There is no single overarching theory of mobile learning but this paper follows Patten et al.'s taxonomy of mobile learning and agrees that the best applications of mobile technology for learning are informed by constructivist, collaborative, contextual, and constructionist learning (Patten, B. et al. 2006).

DNT USER INTERFACE

The DNT includes two shared workspaces, a shared scripting tool, and shared timeline, to enable users to establish a shared understanding while collaboratively creating digital narratives. The shared workspaces include several awareness mechanisms to improve their efficacy. Awareness mechanisms provide users with the, "who, what, where, and how" information about other users' interaction with the workspaces and help users arrive at a shared understanding. The DNT PC client provides a rich graphical interface and the DNT mobile client provides a subset of this functionality.

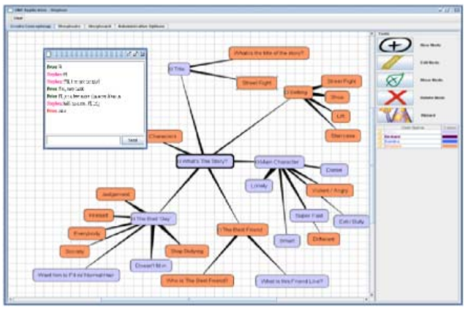

Figure 12: Story Script with Chat

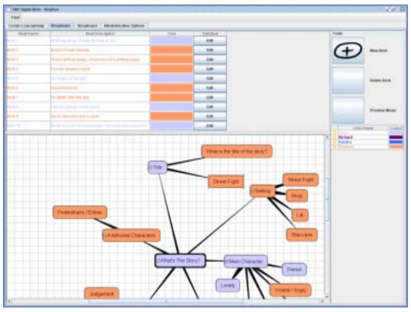

Figure 12: Scene Screen

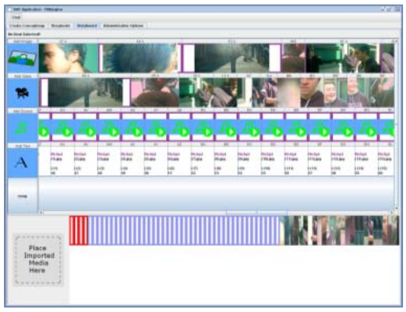

Figure 12: Timeline Screen

The first workspace is a shared scripting tool used in the story generation phase. The second workspace is a shared timeline editor for editing the narrative using images and other media captured by mobile users. The scene screen and timeline screen provide two alternate views to the shared timeline workspace. The shared workspaces provide facilities to allow users collaboratively interact and edit the script and timeline, and provide support for users who are not co-located or are interacting using a mobile device. Users in the field capturing media, and the editors collating this media into the narrative can use this script to inform their actions and provide feedback to each other. The workspaces use a relaxed-WYSIWIS system for the display to support users on different devices with varying capabilities and display sizes etc.

There are three principle screens available to interact with the shared workspaces. () displays the workspace screen used to create a shared script. The next screen () is for the creation of scenes. It allows users to add, edit, rearrange, and delete scenes. The scene screen and the timeline screen () display alternative views of the shared timeline workspace. There is one timeline screen for each scene in the narrative; allowing a division of labour so supporting cooperation. In addition, this timeline interface simplifies media management for the editor as only the media relevant to a particular scene is included in the interface. The same data-structure on the server represents the script, scenes, and timeline. To provide additional support several awareness mechanism are added to the shared workspaces including: feed-through as a carrier of implicit awareness information; workspace support for communication that relies on spatial information; radar views; embodiment in the workspace through colour and status information; awareness of past actions or interaction history; and communications facilities. To facilitate the implicit communication of feed-through awareness information, the DNT system immediately sends all changes to shared workspaces, i.e. the script or timeline, to all users. Therefore, while viewing the script, the users will notice any changes as users add, edit or remove elements from the workspace; so, they will be aware that other users are present and interacting with the workspace.

However, often a user's actions are not immediately obvious e.g., they occurred outside a user's view. So in this case need additional support. If a user wishes to clarify or highlight an action, they can inform the other users via one of the communications mechanisms but in order for this to be efficient users need a frame of reference in the workspace to indicate where the change occurred. The DNT provides support for such deictic language by including common frames of reference in the workspace. The scripting workspace achieves this by representing the relationships in the script the same way on each client. The DNT applies the same concept, a uniform representation on each client, with the timeline interface. This workspace has the added convenience that it includes a ruler representing the time in seconds to play each piece of media; this serves a secondary function as a coordinate system ().

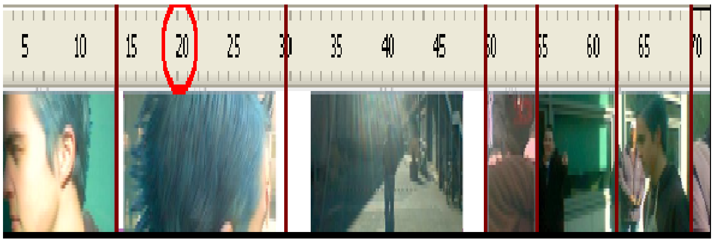

Figure 14: Detail of Timeline Ruler

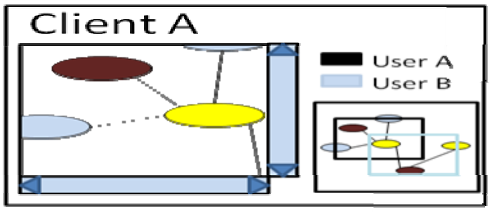

Figure 14: Radar and Miniature View

However, a problem arises with this reference system when using a relaxed-WYSIWIS as the users cannot rely on each user having the same view. The scripting workspace is larger than a user's screen, on either the PC or mobile device, so users navigate the workspace using scrollbars; a radar view presents a small representation of the workspace showing where each user is looking in the workspace. The diagram above () illustrates this concept. The user can use this miniature view to restore awareness of where other users in the workspace are looking.

The DNT uses two features to carry embodiment information, the use of colour, and following Beaudouin-Lafon et al, the DNT uses an *Echo* system that represents a user's actions on another user's interface with icons and animations (Beaudouin-Lafon, M. and Karsenty, A. 1992). There are suitable icons and animations for all actions in the system. For example if a user edits a node of the script, it will be marked with an "Edit" icon and highlighted in that user's colour. The DNT links a colour with each user and applies this consistently throughout the interface, marking all changes to the shared workspace with the colour of whoever made the change, so that the users can see who is doing what.

The DNT records and time stamps all actions the users perform including: all edits to the script and timeline; capturing images and recording sound; communication messages via text chat; and interactions with interface elements. This enables users to replay previous edits to give context to their own work, for example if a user joins the session late this is a useful feature to catch up on progress so far. As communications tools are the key ingredient of collaborative activities the DNT includes a contextualised communication system in the form of a built in text chat. The chat functionality is included throughout the interface and is visible on all screens.

The DNT mobile client contains three main screens: the scripting screen; scene screen; and media capture screen. The scripting screen displays the script using J2ME, and is synchronised with the script on the PC so users can add, edit or remove elements from the script. The scene screen contains a list of scenes in the digital narrative and users can choose to add, edit or remove scenes using this interface. When users select a scene, the DNT will annotate all further media captured with this scene name, so providing the editor with additional context relating to the media. The third screen, the media capture screen, provides tools to capture images, record sound, or create text frames. To inform the filming groups of the progress of the digital narrative, and help them maintain a shared understanding with the editors, all devices can request an up-to-the-minute version of the digital narrative movie file.

ADDRESSING ISSUES WITH THE MOBILEDNA

As described earlier difficulties experienced by participants of the mobileDNA workshop include: maintaining a shared understanding between the filming and editing groups, managing media files, communication between groups, and providing scaffolding to the process. To address these issues the DNT system provides shared workspaces that all the groups can simultaneously view or edit, automatic file management facilities, and an integrated environment. To facilitate a shared understanding between the filming and editing groups users can view the script at all times but unlike with the printed version used in the DNT prototype, the DNT sends any changes made by the editing group to all users. In addition, the filming groups must also make an explicit decision to which scene of the narrative a piece of media is relevant to, in this way reinforcing the connection between the script and the image capture process. The filming groups often take too few images and must wait until the editors inform them of this fact before they can act on this information. If the filming groups were able to see partial results of the editing process, they would notice this lack themselves and remedy the situation by taking additional pictures. Therefore, the filming group can request an up-to-the-minute version of the digital narrative.

To improve file-management the DNT automatically annotates the captured media with the scene name that identifies the media with the correct scene. This media is then automatically included in the relevant scene without needing the editors to manage the files. Furthermore, with the DNT prototype, the filming groups typically capture multiple images before sending them via MMS in a batch process to the editors thereby reducing the amount of parallel editing possible, as the editors must wait for the media. The DNT automatically transfers the captured media, so freeing the filming group to concentrate on image capture rather than routine tasks like transferring files to the editors. In addition, the editors get greater feedback regarding the progress of the filming groups as they receive the media directly. The system uses the same shared data-structure to represent all phases of the process from the scripting, the scenes, to the timeline that represents the DNT. The three main advantages of this seamless approach are that it is possible to have similar interfaces across platforms, to include awareness mechanisms throughout, and to provide scaffolding support throughout the entire process. Finally, the DNT includes an embedded chat system to facilitate communication between the groups.

ARCHITECTURE OF MUSE

The DNT is an application designed to support users collaboratively creating digital narratives using mobile phones. To provide for this functionality the DNT uses the MUSE system. The MUSE system provides a reliable platform for creating constructivist, constructionist, contextualised and collaborative applications. MUSE contains four principle components (): the MUSE application server, a collection of services, the MUSE middleware (), and MCSCL client applications for desktop PCs and mobile devices. MUSE uses the java platform and XML is the main data-representation format. For communication over different networks, it has a transparent network layer, abstracting from the client applications the differences between TCP/IP, HTTP, Bluetooth, and MMS.

Generic systems have the potential to overcome the limited reuse potential of specific tailored systems and the general trend in CSCL is towards generic system in the last five years (Lonchamp, J. 2006). Dimitracopoulou, while describing current trends for the design of collaborative learning systems, mentions that it is "important to provide flexible architectures and customisable tools" (Dimitracopoulou, A. 2005). MUSE uses a service-orient architecture (SOA), which consists of loosely coupled reusable components that provide a flexible, reconfigurable platform on which to develop MCSCL client applications.

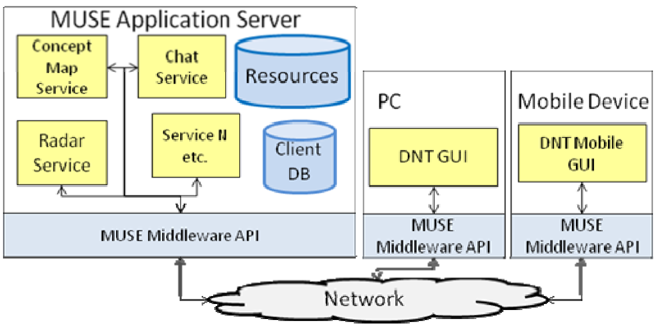

Figure 16: Architecture Diagram

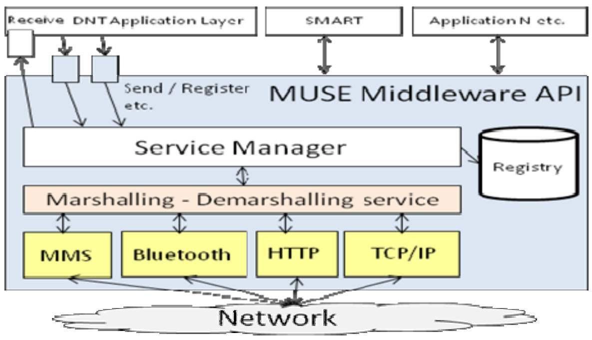

Figure 16: MUSE Middleware

The MUSE central server contains the services used by the DNT, and other MCSCL clients in general, and references to resources needed by the services, e.g. databases or files on the server. The server contains a *client database* that lists devices using the MUSE system, which contains basic criteria about each device, for instance their display capabilities. All messages pass through the application server, which manages routing, forwarding or filtering of the messages before responding to clients based on their device profiles. For example, while using the DNT if a user scrolls a workspace view the client informs the server, which then forwards updated coordinates to PC clients, but not to mobile clients.

To support the DNT client application, the server currently contains several services including: the concept-map service; chat services; radar services; rendering service and additional awareness services. The *concept-map* service is central to the DNT application and manages the XML documents used to represent the concept-map, storyboard and timeline and ultimately the complete digital narrative seamlessly. This service orders all actions from the clients before making changes to the documents, keeping the XML documents consistent. The *chat* Service handles all text communication between users. The *radar* service tracks the users' position in the workspaces, providing awareness of location. The *rendering* service processes the XML representing a digital narrative and converts it into a movie file format. In addition, the MUSE central server includes a *history* service that records all interaction with each service and logs all messages sent to the server. This log provides a source of information for the researcher using the MUSE system. Client applications also can use this service to supply context information to give users an awareness of the past.

MUSE includes a middleware layer, accessed with a simple application-programming interface (API), to provide networking facilities and interact with the SOA. The MUSE middleware provides functions to login or leave the server, retrieve a list of services available on the server, to register or un-register for these services and finally to send messages to a service. The MUSE middleware contains an implementation of the *subscribe/publish* paradigm, to mediate interaction between clients and services and support the SOA, and a *service registry* containing a list of discoverable services that users can look-up and subscribe to using the MUSE middleware API. The DNT PC client can use the services provided by a server using this API. The MUSE middleware allows clients to send messages to and from the server using a transparent message transport layer over various protocols and networks e.g. Bluetooth, HTTP, TCP/IP, and MMS. Additional facilities of the networking layer include a marshalling service and a persistent asynchronous invocation mechanism. This invocation mechanism overcomes two problems with unreliable mobile networks, high message latency, and frequent disconnections. These invocation semantics (*at most once*) allow the MUSE client to pass messages to the networking layer in a non-blocking way, allowing other operations to proceed in a high latency setting. The networking layer queues messages to allow disconnections, the MUSE repeatedly tries to execute the request until it has either succeeded or definitely failed. In this way, the MUSE networking layer provides reliable network to the application layers.

In summary, the MUSE system contains four principle components: the MUSE application server, several services, the MUSE middleware, and MCSCL client applications for desktop PCs and mobile devices. The MUSE uses a central application server to simplify the consistency maintenance algorithms and to reduce the number of messages needed. To support the DNT client applications the MUSE server currently contains several services including: shared workspaces; chat communication facilities; logging tools; awareness mechanisms; and digital movie rendering facilities. The MUSE middleware provides an API so client applications can send messages to the server, look-up services and register an interest in events from a service. The MUSE middleware provides a transparent network layer to provide reliable network transport over several networking protocols. The MUSE uses the SOA paradigm to decouple the components of the MUSE and an open XML message format for all communication to allow other applications to use the MUSE services.

EVALUATION

A full user evaluation of either the DNT or MUSE is outside the scope of this paper instead the focus is on the performance of the DNT to see if it is a viable tool. Therefore, this study records the permissible image resolutions, the transfer time, and cost over the various networking technologies, the responsiveness of the PC interface and the time taken to propagate updates from the PC to the mobile devices. The mobile devices used are Nokia N73 mobile phones.

The DNT captures images in JPEG format, with resolutions ranging from 320x240 to 800x600, which result in file sizes ranging from 10Kb to 75Kb. It takes 6 seconds to capture and save images at the small end of the range and 17 seconds at the larger end. To enable comparison, all file transfers and cost metrics mentioned use a file of size 75Kb. It takes 17 seconds to transfer the file with HTTP over a 3G network, and 3 seconds with Bluetooth. File transfer over MMS depends on the mobile operator's network, with recorded times ranging from 30 seconds to over 2 minutes.

The cost of using HTTP via the local mobile phone network is €0.99 for 50MB per day; via MMS it costs €0.25 and via Bluetooth is free. The MUSE system uses short XML messages to communicate between the MUSE clients and the MUSE central server. These XML messages are typically 1Kb in size so message exchanges via a local area network are very quick, with a round trip time between the client and the server of less than 100 milliseconds. However, on the mobile device it takes 2-3 seconds to parse the XML messages, causing a slight propagation delay. The updates reach the phone in between 1-3 seconds with a further 2-3 for parsing resulting in a range from 3-6 seconds at worst case. The number of simultaneous users able to use the DNT is not restricted, but further user studies will need to ascertain practical limits.

CONCLUSION

DVP is an established activity that facilitates collaborative learning. Typical problems observed with DVP include: expensive equipment; it is a time consuming activity; and it is difficult to keep all users engaged throughout the process, especially filming and editing. The mobileDNA address these through carefully designed data and workflows that support the emergence of collaborative creative interactions among people. These data and workflows are instantiated in the digital narrative creation activity and the DNT prototype. However, some problems remain: maintaining a shared understanding between filming and editing groups; difficulties with file management; communication between groups; and scaffolding the process. To address these difficulties, this paper described the design and implementation of the DNT, which facilitates users collaboratively creating digital narratives with PCs and mobile devices using MUSE to provide a seamless integrated environment.

The focus of the evaluation of the DNT in this paper relates to its functional performance i.e. is it possible to build a tool to support collaborative digital narrative activities? To address several of the difficulties of the DNT prototype the DNT system provides an integrated seamless environment with all data-structures and files managed centrally. To help users maintain a shared understanding, the DNT provides a collaborative script, storyboard, and timeline that are accessible via PCs and mobile phones at the same time. To simplify file-management the DNT labels media with the scene name so automatically appears in the correct scene in the user interface. In addition, to create a seamless experience, the DNT automatically synchronises the data structure representing the script, scenes, and timeline with the server, and transfers media between PCs and mobile devices. The limitations of the DNT principally relate to the underlying technology and networks used. For instance, the cost of sending HTTP and MMS messages over the local mobile operator's network or the limited range of Bluetooth. In addition, when using mobile devices the image resolution is typically lower than what is possible with specialist devices.

The main contribution of the DNT is that it provides an integrated MCSCL environment for creating digital narratives using mobile phones and PCs. In this way, the DNT enables users to create digital narratives using a seamless application designed to overcome the limitations of the DNT prototype. In addition, the MUSE architecture provides a stable and reliable platform for building collaborative applications across mobile devices and PCs. Another contribution of the MUSE is that all interaction and communication is logged and recorded by the system, thereby, providing a valuable source of data to the researcher interested in mobile learning and collaboration applications. The future direction of this research will focus on evaluating the DNT in user studies to ascertain if it can address the limitations of the DNT prototype in practice, and enable users to maintain a shared understanding between the filming and editing groups. A further direction for this research will concentrate on integrating new or existing mobile learning applications to take advantage of the MUSE platform. For instance, one application can make use of this open architecture is SMART (Byrne, P. and Tangney, B. 2006), a mobile application for creating stop-motion animations on mobile phones, which uses this API to enable users to send movies to the server for rendering or to each other.

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Reflections on the Role of Technology in City-wide Collaborative Learning

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ABSTRACT

In this paper we investigate collaborative learning that takes place in a city with the support of mobile and wireless technology. Based on a literature review, we identify and discuss four main roles: (1) supporting performance of shared tasks, (2) supporting social networking, (3) supporting active participation, and (4) supporting visibility of learning. Each role is illustrated with a short scenario and related works are discussed. We claim that the full potential of new technology emerges from the possibility of supporting learning that comes from *exploration*, *interaction*, and *serendipity*. Realizing this potential however raises a number of technical challenges that are still largely unexplored. In particular, we claim that there is a need to move from applications designed to support specific learning experiences to a service-oriented infrastructure that eases the development and adaptation of applications for multiple and interleaved learning experiences. In this perspective, we need to identify services that are common across different learning experiences and that can be used as building blocks to develop specific applications. In this perspective, the identified roles are the first step towards the definition of a design framework for informing the development of technologies supporting city-wide collaborative learning.

Author Keywords

City-wide learning, collaborative learning, learning scenarios

INTRODUCTION

The advances and diffusion of mobile and ubiquitous technology have influenced considerably our everyday life (the way we communicate, arrange our activities, etc.), changing our habits and practices by freeing us from the confines of the desktop activities (Williams et al., 2006). Ubiquitous and mobile technologies have also affected the younger generations that have grown up being familiar with those systems and being used to handle them. For example, a study conducted by Jones et al. (2004) proved that children are attracted by the use and potential of pervasive computing and mobile technology, increasing children opportunities to engage with the urban environment. In general, there has been an increasing interest in physical spaces and on the role of technology in city-wide environments (Dieberger, 1997; Ishida et al., 2000; Tanabe et al., 2002; Cherubini et al., 2004; Koizumi et al., 2005; Williams et al., 2006; Adamczyk et al., 2007; Calabrese et al., 2007). Many projects investigating new kind of learning activities have moved their attention to the urban environment (Valentine et al., 2000; Jones et al., 2004; Nehm 2005, Petersen et al., 2006; Lee, 2006, Lim et al., 2006). These technologies might facilitate learners to continue their learning outside their classrooms, when and where they desire, through exploration and interaction. Learning activities will not be confined simply to formal learning in the classroom, but more activities will be carried out outside it, e.g. in museums, libraries, factories, by experiencing things at hand, through serendipitous encounters and interaction with more experienced peer or experts in the field.

This research is conducted in the framework of the FABULA project (www.idi.ntnu.no/~divitini/FABULA/). This project aims at developing novel principles and technical solutions for city-wide learning enabled by seamless roaming in mobile networks, with focus on services that allow people to take an active role in collaborative processes of knowledge construction and sharing.

In this paper we investigate how technology can support different aspects of mobile and collaborative learning in a city-wide context. The research area we want to address in this paper is at the intersection between city-wide application research and collaborative learning, without limiting our discussion simply to mobile learning systems, but opening up to all kind of applications in the intersection highlighted in Figure 1. That is, our focus is not simply on the role of mobile technology, but all kind of technology that can support learning that occurs across urban locations, learning arenas and communities.

We believe that these applications open up for a new space of possibilities that is still largely unexplored, challenging many of our assumptions on learning experience and communities.

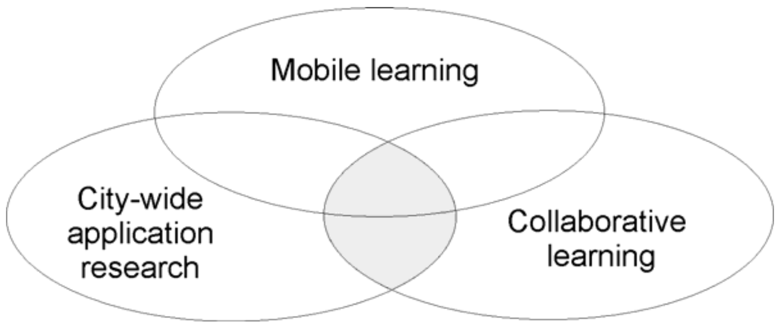

Figure 1. Area of research.

City-wide technologies allow supporting not only small groups of students performing specific tasks, but also the collaboration that takes place within loosely coupled groups. Considering the mobility of students, we believe that support for learning cannot neglect issues connected to participation to multiple communities, and how mobility across communities can hinder or foster learning. This choice finds a clear grounding in theoretical backgrounds that look at learning as situated and, as such, relates to learning as participation in communities (Wenger, 1998). While the Internet has put the focus on distance education and on collaboration among people that are geographically distributed, mobile and wireless services allow to bring again into the picture local issues, recognizing the critical role of place and local communities in learning, supporting not only interactions with "others around the world, but also –and, perhaps more importantly, with people nearby. Groups of people using these tools will gain new forms of social power, new ways to organize their interactions and exchanges just in time and just in place" (Rheingold, 2003). The challenge is therefore to design what Thackara (2005) calls new geographies of learning, "configurations of space, place, and network that respect the social and collaborative nature of learning – while still exploiting the dynamic potential of networked collaboration" (Thackara, 2005).

In this paper we reflect on the different roles that technology can play in city-wide collaborative learning. Focusing on a socio-constructivist approach to learning, we have identified in the literature four main roles: applications for (1) supporting performance of shared tasks, (2) supporting social networking and matching, (3) supporting active participation, and (4) supporting visibility of learning. Each role is illustrated with a scenario and a brief literature review of relevant systems. We underline here that the distinction that we provide is mainly for analytical purposes and the different roles are often played in an interleaved way in any given system. The four main roles presented in this paper might not be exhaustive; for instance, we have not considered supporting collaboration between people in real and virtual world, since our scope was mainly to focus on co-located peer collaboration rather than remote collaboration.

After presenting the different roles, we discuss challenges in the design of support for city-wide learning. In particular, considering the dynamic and the emerging nature of the learning experiences that we aim at supporting, we claim the need to design learning systems that are not monolithic entities, but are rather a dynamic and contextualized composition of services satisfying specific needs. In this perspective one of the challenges ahead is to look at commonalities among different learning contexts to identify basic services that can then be combined, possibly by end-users, to provide more complex support. An initial list of these services includes management of social networks and shared places, as well as support for contextualization of learning.

ROLES OF CITY-WIDE APPLICATIONS IN SUPPORTING COLLABORATIVE LEARNING

Performing Shared Tasks

This first scenario looks at the city as an arena for performing collaborative learning tasks. Its purpose is to highlight the possibilities of performing shared tasks among a group of people that are distributed.

> The teacher has just given out a new assignment about pollution. The students have to investigate the status of their local environment. Anna, George, and Isabel are assigned to the same group and they decide to divide their tasks. Anna will go out and collect data in the main street, George will cover the area around the main square, while Isabel will monitor the status of the river.
>
> While Isabel is at the river, she meets an old fisherman who has a lot of information on how pollution has impacted during the years the life in the river. She uses her PDA to contact the others and ask if they have some questions they would like to ask. In the meanwhile, Anna sends to George the data she has collected to check if the process she is following is correct.
>
> While out in the field, George meets a class working on a similar project. He shows the data he has collected so far to one of the students. The teacher of the class overhears the conversation and joins in, giving some good tips about their approach. George is now able to answer Anna in a more precise way.

Table 1. Scenario 1 – Shared tasks.

Pinkwart et al. (2003) described the realization of a few scenarios for cooperative use of Personal Digital Assistants (PDAs). They also outlined the possibilities for applications to support collaboration between students in the classroom and other engaged in activities outdoors, allowing them to exchange their ideas and hypotheses peer-to-peer through a mobile application. The students can also project their finding onto an electronic whiteboard to initiate a classroom discussion giving visibility to learning activities to a broader public. This allows another aspect of collaborative learning in the city that will be discussed later at the end of this Section.

Similarly, the mediaBoard system, presented in (Colley et al., 2004), encourages learners to contribute to online projects. This system was designed for supporting communication and the exchange of ideas among students using text and picture sent using either mobile phones or PC. Cook et al. (2006) presented a learning environment that facilitates teamwork over multiple communication devices making use of a mediaBoard system as a multimedia message board. Students used the mediaBoard to communicate with their team and collaborate together to complete their assignment.

Several other projects have addressed the issue of supporting performance of shared tasks in the form of collaborative games. Kurti et al. (2007) proposed a game-base activity that fostered children’s collaborative problem solving skills within a group of students across different locations (indoor in a museum and two others outdoors location). Several smart phones, in addition to desktop computers, were used for several purposes: to support communication with instant messaging applications, to trigger events through a code reader, to control the contents related to a specific task, etc. Activity Theory was used to guide the design process; the activities were designed in order to impose the division of labor that successfully forced the coordination of tasks and collaboration among subgroups.

Savannah is another important project that promotes collaborative learning through a strategy-based adventure game where a virtual space, the savannah, is mapped directly onto a real space. The children act as they were lions in a savannah, navigating through the environments by using mobile handheld devices. Using aspects of game play, Savannah challenges children to explore and survive in the augmented space. In order to succeed they must coordinate their efforts adopting the strategies used by lions (Benford et al., 2005). The development of collaborative strategies in games has been observed also in other city-based games, like in the CityTag project (Vogiazou et al., 2007).

Social Matching and Social Networking

With this scenario we want to highlight the possibility to enhance the social aspects of collaborative learning in the city environment mainly in two ways: by strengthening the feeling of connectedness among friends and by promoting interaction with strangers based on affinity.

Back to school Anna updates her profile on the mobile by setting ‘pollution’ among her interests. A few minutes later, the affinity system of the school notifies her about someone else in her vicinity that has similar interests. Anna decides to send a message to this peer and invite him/her to meet. The other peer accepts, it is Cristine, a student that Anna does not know so well. They sit together at a table and they discuss about their common interests. Cristine is doing an assignment about greenhouse effect and its local impact. Anna thinks that she could integrate Cristine’s information on the assignment she has to write, while some of the information that Anna might collect during her visit could be useful for her as well. They exchange their contacts and agree in sharing their information. Eventually, Anna starts writing her assignment, so she sets the status of her mobile to “busy working”. Then, she checks the status of her friends and she finds out that also George has set the same status. He is probably working on their assignment as well. She sends him a message that will hopefully cheer him up. She feels more connected to her companion, and starts working more enthusiastically.

Table 2. Scenario 2 – Social matching and social networking.

The sense of connectedness is described by Baren et al. (2003) as “a positive emotional experience which is characterized by a feeling of staying in touch within ongoing social relationships”. The research group working on the New Sense of Place project believed that the location-signalling capability of a system holds great potential in the sense of collective presence in a landscape. The possibility for locating our friends can improve our sense of being a community (Jones et al., 2004). The mediaBoard system, presented earlier, also supports a ‘community of practice’ approach (Wenger, 1998) making a group of learners feel more involved in what they are doing together (Colley et al., 2004). As outlined by Morken et al. (2007a) connectedness plays an important role in determining students’ well being as well as their readiness of getting involved with others in relation to the work they have to perform and their learning. They also stressed that physical connectedness, i.e. sharing the same physical spaces, does not necessarily imply feeling connected. For instance, when students are visiting a site they are not necessarily “in touch” with the other visitors.

In the MyArtSpace project, the authors proposed a system to support museum visit through mobile phone web-based services. The system, among other functionalities, gave the possibility to pupils to visualize who else has collected the information about an exhibit, so they could find each other and discuss about it face-to-face (Vavoula et al., 2006). This solution, however, was not so successful. Students were already engaged in collaboration in small group and they probably did not need further discussions with other peers. A possible solution to this problem might be represented by another system; Szymanski et al. (2008) proposed an electronic audio guidebook system to support interaction among companions during museums and cultural heritage sites. Their prototype implements a so called *eavesdrop* functionality that promoted exploration of the surroundings without hindering interaction with others.

Jones et al. (2005) stressed the importance of **P**eople-to-**P**eople-to-geographical-**P**lace, or P3-Systems that by providing location information can reinforce existing social bonds, and help individuals to meet appropriate people and "turn acquaintances into friends" (Jones et al., 2005). CampusMesh represents one of these systems; it is a location aware geotemporal social matching application. Many other examples can be found in (Jones et al. 2004). However, there are not so many examples of systems designed for collaborative learning applications. MapTribe, for instance, is a collaborative mobile learning tool that enables group of users to display the map of the city and the position of their friends, supporting social networking but not supporting social matching (Cherubini et al., 2004). Borcea et al. (2008) presented the MobiSoC architecture for mobile social computing applications to improve social connectivity, but also support other functionalities, like the People-People Affinity Learning module that computes social affinities based on factors like similar interests, similar background, common friends, or co-location.

Support Active Participation

In this subsection, by active participation we mean supporting participation in the life of a community, in particular of the city.

The Municipality has recently made available a web service to allow citizens to send in comments and suggestions for improving the town. The local school is out for a day in the park. Year 1 notices that the access to the park is rather dangerous for the small ones and for disabled. They therefore decide to submit the issue to the municipality. On the spot, they take some pictures of the area and upload them to the new system with some explanation of the problem. In the coming days many others leave comments and annotations, confirming that this is actually a problem. Some suggests solutions by attaching sketching to the initial message. A group of architecture students volunteers to design a solution as part of their semester project. Soon this will become a case that the municipality has to address.

Table 3. Scenario 3 – Active participation.

Cherubini et al. (2004) suggest that IT, and location awareness applications in particular, may support a shift of attitudes from people that are simply leaving the city towards a more vibrant citizenry that can *master* it. In their opinion, people who *master* the city "have an active attitude towards the community, they are interested in local politics and want to be up to date with all the activities or initiatives around". On the other hand, people who *live* the city are those that are not "interested in exploring unknown parts of the city, feel not responsible for the public aspect of the city, etc." We share their believe that IT by offering new services that are more social and situated, could fill the gap between a passive citizen to a more active one. Recent research efforts have actually started looking at active participation in the city.

Pleasurable Cities, for instance, was a FutureLab (www.futurelab.org.uk) exploratory study that looked at how the technology owned by young people could be used to encourage them to express their opinions about their local communities. The main objective was "to provide new channels for young people to express their use of space, and to discuss and comment on their expectations and desires for any development or change of those places" (Lee, 2006). This was realized by supporting the link between visual real world signs and virtual conversations, both locally via text messages and remotely via web-based message boards, this also gave visibility to their contributions.

A few more projects from FutureLab should be mentioned discussing this specific role of technology. One of these projects is Snapshot that approaches citizenship education through the activity of news photography. It is intended to immerse users in a virtual environment where the social and cultural issues important to today's young people are played out, in order to engage them by asking to take a stand as they investigate and report on the actions they observe (Williamson, 2004). MobiMission, instead, is a social game in which players use camera phones with location-based capabilities to create, share and reply to missions created by other. Its main purpose is to engage players in new activities with the physical world and with each other (Grant et al., 2007).

Active participation can also be realized in other ways. eCell, for instance, promotes active participation through appropriation. Students could claim unused spaces to work with their project and group activities (Brodersen et al., 2007). eCell also support the visibility of learning that is discussed in the next subsection. The Participate projects, instead, promote active participation by making the citizens more aware of what is happening in their environment. The main objective of this project is to promote, through pervasive, online and broadcast media new kinds of mass-participatory events. Within this project a game called "Professor Tanda" has been developed in order to engage the public and make people reflect and be aware of their behavior's environmental impact (Wright et al. 2007).

Support Visibility of Learning

With this scenario we want to highlight the possibility to support visibility of learning. We believe this is an aspect that should be supported in a urban environment for promoting the integration of educational initiatives in the activities of the city.

The city has made available in a number of public areas, large interactive displays that schools can use to exhibit their work to the community. Year 1 of the primary school is using the display system to give visibility to their project on local architecture. There are pictures they have taken, a video, and a brief description of the work. People might interact with the display to look at the different exhibits, navigate in the system, and use their mobiles to leave comments. Year 1 is amazed to get so many positive comments to their work. The previous exhibits they organized had been attended only by parents. This system gives schools the possibility to reach a wider audience. A professor teaching architecture at the local university is impressed by their thoughtful analysis and he invites them to visit the exhibit that the university has just set up at the local museum and he offers to be their guide. What a great opportunity!

Table 4. Scenario 4 – Visibility of learning.

The eCell is a prototype system for supporting group/project activities in school environments. It consists of a private, inner display and a public, outer display that allowed people passing by the eCell system to learn about others activities (Brodersen et al., 2005). Morken et al. (2007a) stressed the utility of shared display systems to promote cooperation among students by giving visibility to information, indirectly support coordination and supporting socialization.

Roschelle et al. (2002) presented the ImageMap system developed by SRI International as "an assessment feedback system for supporting media-rich learning conversations". Students receive on their handheld device an image (e.g., graph, map, photo) and a question related to it. Each student annotates the image with a response that is sent back to a server. This server receives these responses, aggregates and projects them on a public display, showing also the distribution pattern of different answers, allowing students and teachers to see and discuss about them.

Within this scenario we want to briefly present also other projects that enable interaction and exploration in public places of educational contents that have not necessarily been produced through a learning activity. They offer the possibility for learning in a public place, making learning visible to co-located people. La Piazza project represents one example. La Piazza focuses on intergenerational learning in public spaces, e.g. museums, community centers, civic networks, installations in public squares. The focus of this project is both on intergenerational learning scenarios supported by technology in public social spaces, and the ecological integration of technology interfaces and tools in the physical architecture of those public spaces to support meaningful and playful intergenerational learning activities (Barajas et al., 2006). One of the La Piazza project case studies is represented by the Space Signpost (www.spacesignpost.com/), which is a signpost, installed outdoors in Bristol's Millennium Square, that makes space science accessible and visible to everyone.

CONTEXTUALIZING LEARNING

From the discussion on technology in the previous section, we see that city-wide applications that support collaborative learning have considerable potential in supporting both formal and informal learning. The full potential can be realized only by acknowledging and supporting the processes of collaborative knowledge creation that take place thanks to the interaction with different actors inside and outside the performance of predefined tasks. Now more than ever there is a need to acknowledge that learning comes from *exploration*, *interaction*, and *serendipity*. City-wide applications have the potential to support these facets of learning in ways that were not possible with traditional desktop applications.

Supporting these facets of learning requires technology that helps learners to take advantage of their context to promote learning. The capability of technology to capture the physical surrounding context until few years ago has been rather limited, being mainly based on direct users' input or on tracking of the status of the situation as represented in the computer. The emergence of mobile and ubiquitous computing has opened new possibilities to build an increased awareness of the surrounding context, for example by tracking the position of users or by sensing environmental data, e.g. the temperature. These possibilities have often led to an increased interest in context-aware computing. Many of the applications in this area are however based on oversimplified accounts of the context where a user is acting (Greenberg 2001). A contextualization of learning to be successful has to take into account that the context is not only given by physical variables, like the location or temperature, but more importantly it has to take into account social aspects. In this perspective we refer to the notion of situated learning introduced by Lave and Wenger (1991) to stress that learning does not happen in a vacuum but is situated in a given context. In this perspective, the acquisition of knowledge should not be fragmented and detached, but tied to a specific context (Lave et al. 1991). When situating learning, it is important to account for local and remote social networks, both predefined and emerging, in order to support collaboration within pre-defined social structure but also to take advantage of serendipitous learning that might be triggered, for example, by people co-location.

In this perspective, we think that the most interesting scenarios for city-wide collaborative learning are the ones that provide a high degree of situatedness with respect to the social network and the place where learning experiences take place (Figure 2).

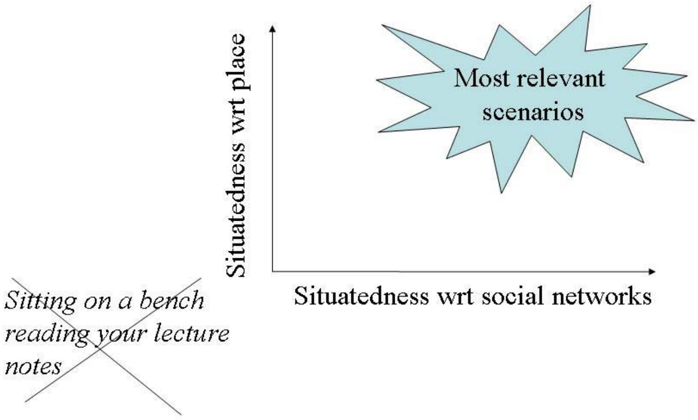

Figure 2. Relevance for city-wide learning scenarios.

All these scenarios have in common the need to provide representations and management of social networks that users are involved in and of the places that these social networks inhabits. Designing applications that support these scenarios will require:

1. To provide representations of social networks which are flexible but meaningful, capturing, when needed, the different forms of interleaving of multiple social structures.
2. To provide mechanisms to support participation of users to multiple communities, considering the need of building an overview while keeping focus, and the collaborative co-construction of identity, at the individual and community level, through interaction and participation.
3. To provide mechanisms to share places within communities of users, supporting different levels of abstraction from the geographical positioning and associating them with conventions and rules of conduct.
4. To provide mechanisms to define shared context of learning, taking into account physical and social aspects of the context, and to support the co-construction of shared meaning within different social networks.

We suggest that these requirements should be realized as basic services on top of which more specific applications might be built.

In general, the context of any learning experience is dynamic, though the level of dynamicity might vary. New people might enter into the social network, different services might be made available, new places might become relevant for a community. As outlined in (Morken et al., 2007b) "the required flexibility can be provided only with a technological infrastructure that supports the rapid development of learning applications and their deployment, promoting grass-root innovation". In fact, designing systems that satisfy the varying and dynamically changing needs of communities is challenging. Though a system might function well at a certain point in time, it might not necessarily be able to evolve with the community. It is important therefore to design learning systems that are not monolithic entities, but are rather a dynamic and contextualized composition of services satisfying specific needs. In this perspective one of the challenges ahead is to look at commonalities among different contexts to identify basic services that can then be combined, possibly by end-users, to provide more complex support. This is one of the main challenges addressed in our project. Design and development, in this perspective, have to be strongly coupled with deployment. In fact, learning systems are complex socio-technical systems. Support must be provided to promote this co-evolution, in the form, for example, of guidelines, tailoring facilities, end-user development tools.

Learning systems require a high degree of tailoring to the specific needs. The tailoring might go from setting of predefined parameters to the actual development of new services, following the paradigm of end-user development (Lieberman et al., 2006). Given the complexity of defining the context and its evolution, different mechanisms, with different level of automation and user control, should be in place. Also, support should be provided to allow users to easily make available within communities resources that are relevant and share them with others, creating a shared context for learning.

CONCLUSIONS

In this paper we identified four different roles that technology can play in supporting city-wide collaborative learning, mostly for co-located peers rather than remote ones. For future work we might consider other roles as well, such as real world and virtual world collaboration, etc. However, for each of the roles presented here we provided an illustrative scenario and references to some literature. Based on the identified roles we outlined challenges for technology design. In particular, we suggested that there is a need to support the definition of common services to ease the development of applications for specific learning experiences. In this paper we identified community and place management as two services that are core to city-wide applications.

This paper does not provide any technological or theoretical final solution. Rather, it reflects on the role of technology to start the definition of a design space for the support of city-wide collaborative learning. Identifying the roles of technology and challenges is the first step. Our future work includes the development of specific services and their combination to realize applications fulfilling the needs of specific learning communities. In this process, potential users will play a central role.

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Mobile VLE vs. Mobile PLE: How Informal is Mobile Learning?

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ABSTRACT
Mobile Learning Systems are often described as supporting informal learning; as such they are a good fit to the idea of Personal Learning Environments (PLEs), software systems that users choose and tailor to fit their own learning preferences. This paper explores the question of whether existing m-learning research is more in the spirit of PLEs or Virtual Learning Environments (VLEs). To do this we survey the mobile learning systems presented at M-Learn 2007 in order to see if they might be regarded as informal or formal learning. In order to categorise the systems we present a four dimensional framework of formality, based on Learning Objective, Learning Environment, Learning Activity and Learning Tools. We use the framework to show that mobile systems tend to be informal in terms of their environment, but ignore the other factors. Thus we can conclude that despite the claims of m-learning systems to better support informal and personal learning, today's m-learning research is actually more in the spirit of a VLE than a PLE, and that there remains a great deal of unexplored ground in the area of Mobile PLE systems.

Author Keywords

Informal Learning, Personal Learning Environments, Virtual Learning Environments

INTRODUCTION

In e-learning we are used to talking about systems that manage the teaching/learning experience, for example, Intelligent Tutoring Systems (ITS) that modify or personalize that experience (Graesser and van Lehn et al. 2001) , and Virtual Learning Environments (VLEs) that act as common space for teachers and their students to share resources and communicate with one another. For example, Moodle and Blackboard are VLEs that provide educators with online learning resources structured into courses and activities, teachers can interact with the learners through tools such as discussion forums and email, and set simple online assessments and tasks[15].

Since 2000 we have also seen the emergence of Personal Learning Environments (PLEs). These are an alternative to the VLE approach where students are given back the control of their learning space (van Harmelen 2006), in a PLE the student can manage their own learning experience, for example by managing their time, helping to organise learning goals and activities, and collating reference material. For example, PLEX - a software system that provides a learning space where the learner can organize their learning activity and monitor their learning processes towards desired learning outcomes by revising their learning plans as needed.

A few differences between VLEs and PLEs have been argued. The main difference is that in a VLE the learning resources and learning objectives are more in the control of the institutions rather than the learner themselves (PLEs). We would argue that a VLE is more like an administration or management environment rather than a learning environment. In PLEs students have more flexibility on the control of their learning experience.

In the last few years a debate has started about which of these approaches suites a new generation of tech savvy teenagers (sometimes called Generation Y, or Millennials), this new generation has been stereotyped as Digital Natives (Prensky, 2001) – people who are at home online and come to an educational institution with their own set of digital tools already in place (for example, email, social groups and web presence). More recent reports have suggested that the change is less extreme than this and more balanced across the population as a whole (Rowlands, Nicholas et al. 2008) but nevertheless it seems that modern Web 2.0 style tools and applications have changed students' expectations of what their learning environments should provide.

This should be good news for m-learning systems, which are often described as supporting informal learning (Sharples 2002). This is because mobile systems seem to be in the control of the student rather than the teacher, for example they may be accessed and used at a time of the student's choosing, and may even run on the student's personal device (such as a mobile phone, or digital music player). On the surface then, m-learning systems are more like a PLE than a VLE, and therefore will be more appealing to the changing needs of new students.

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[15] Moodle (www.moodle.org) and Blackboard (www.blackboard.com)

However the term informal learning can be used in a variety of ways, with subtle differences in meaning, and it is unclear to what extent we might describe m-learning systems and applications as supporting informal learning.

In this paper we analyse the mobile systems that were amongst the presentations from M-Learn 2007 (a total of 17 systems from 40 papers) in order to give a clear picture of whether most mobile systems really do support informal learning, and thus whether they are in the spirit of PLEs or VLEs. To do this we have had to create a model of informal e-learning that is detailed enough to differentiate between different types of formality. Our goal is to assess to what extent m-learning systems have embraced the PLE ideal, and to give a framework within which future advances might be evaluated.

The paper is structured as follows: *Background* describes related work on informal and formal learning and places this within the m-learning domain. *The 4D Model of Formal Learning* presents our framework, explains the dimensions we use to assess a given system and gives some examples. The *Review of M-Learn 2007 Systems* places each of the 17 systems presented at last years M-Learn conference into our model in order to assess how formal or informal they are. *Analysis and Discussion* presents an analysis of the results in order to reveal trends within the review, and finally *Conclusion and Future Work* summarises our findings and suggests future directions.

BACKGROUND

With the swift advance of Information technology, learning is no longer confined in a specific location, it could be *'beyond the classroom'* (Bentley 1998) and *'informal and incidental learning in the workplace'* (Marsick and Watkins 1990) and (Dale and Bell 1999). Mobile devices have the potential to make learning more diverse and interesting (Sharples 2002). Learning theory is an attempt to understand the processes and factors involved in learning, four different orientations of learning have been identified: behaviour, cognitive, humanistic and the social/situational (Smith 1999; Merriam and Caffarella 1991). In general, learning includes formal learning, non-formal learning, informal learning, in terms of their characteristics of learning environment and context (Jeffs and Smith 1990).

Knowles (1975) identified informal learning with self-directed learning, he included five steps: 'To diagnose their learning needs, formulate learning goals, identify resources for learning, select and carry out learning strategies, and estimate learning outcomes'.

Others believe that the self-direction extends to the learners environment, McGivney states that informal learning is learning outside a dedicated learning system, non-curriculum-based learning activities and planned and structured learning (McGivney 1999). '*In intentional formal learning, the goals and the process of learning are explicitly defined by a teacher or by an institution. In intentional, informal learning, the goals and the process are explicitly defined by the learner*' (Vavoula 2004).

Other views that have been expressed include Dale and Bell (1999) who claim that informal learning depends on the work context, and emerges from the experiences of the learner, for example by practicing skills, and Eraut (2000) who links formal learning to accreditation and qualifications.

The difficulty with these existing models of formal and informal learning is that each comes from a different perspective, where they value certain types of informality more than others, for example learning direction over learning location. Thus what is informal to one model could be formal to another.

What is needed is a framework for understanding how these perspectives relate to one another, to help solve this problem we present a 4D Model of Formal Learning, which explicitly considers a number of different dimensions.

4D MODEL OF FORMAL LEARNING

We have based our dimensions on typical "who, what, when, where, why, how" questions; as such we are considering the learning experience as a whole, rather than looking solely at the system. For example, this means that the same system can be more or less informal depending on *how* and *when* it is being used. Figure 17 shows how these six questions form four dimensions (and also how they are sometimes grouped together into higher-level terms such as *context)*.

We have simplified the six questions down to four dimensions by considering Environment (Where and When) and Activity (What and Who) as two rather than four criteria. We have done this for two reasons: firstly, this is the level at which they are commonly described in the literature where *environment* and *activity* are well understood terms; secondly it simplifies the classification and enables effective presentation of the results and thus making it easier to analyse.

Our four dimensions are as follows:

1. Learning Objective (the goal of the activity - *Why* is the student doing this activity?)
2. Learning Environment (the place and time of the activity - *Where* is the learning activity happening and *When* is it happening?)
3. Learning Activity (the activity itself - *What* is it that the student is going to actually do, and *Who* are they doing it with?)
4. Learning Tools (the tools used to do the activity - *How* are they going to undertake the activity?)

<table>
<tr><th>Question</th><th>Dimension</th><th>Higher level</th></tr>
<tr><td>Where</td><td rowspan="2">Learning Environment</td><td rowspan="4">Context</td></tr>
<tr><td>When</td></tr>
<tr><td>What</td><td rowspan="2">Learning Activity</td></tr>
<tr><td>Who</td></tr>
<tr><td>How</td><td>Learning Tools</td><td></td></tr>
<tr><td>Why</td><td>Learning Objective</td><td></td></tr>
</table>

Figure 17: Relationship of *Key Questions* to *Dimensions* to *Higher-Level Terms*.

When placing a given m-learning experience in the framework we say that for each dimension a system is either *student-led, teacher-led*, or *negotiated* (meaning that both student and teacher had some say). This gives us three classifications on each of the four dimension, and thus allows is to potentially distinguish between 81 different types of formality and informality. We capture this in shorthand using S, N or T for each dimension in turn (Student, Negotiated, Teacher). So for example we might say that an experience in which all four dimensions are controlled by the teacher is TTTT, but one in which the Learning Environment is controlled by the student is TSTT.

The 4D Model allows us to step back slightly from disagreements about what constitutes formal learning, it shows that one's opinion of formal learning will change according to which of the four dimensions one holds most valuable. This is how different commentators can draw different conclusions about the formality of the same learning experience.

Example: A School Nature Fieldtrip

To demonstrate our 4D model consider the following scenario:

> *"Clare is using a PDA to record observations that she is making on a school nature fieldtrip. Clare's teacher has asked her to write descriptions of the wildlife that she sees in order to understand more about the food chain. The teacher has asked Clare to use a special journal application on her PDA to write her observations, which then synchronises to a central server so that Clare can access them at a later time."*

Using our 4D model we would classify this m-learning experience as TNTT:

- **Learning Objective** – Set by Teacher (to understand more about the food chain)
- **Learning Environment** – Negotiated (fieldtrip is at a set time and place, but Clare is free to move about within the area as she likes)
- **Learning Activity** – Set by Teacher (to record observations in a journal)
- **Learning Tools** – Set by Teacher (Clare must use the special journal application on the PDA)

We can imagine that small changes could affect the formality of this scenario in different ways, for example the teacher could have let Clare choose the way in which she records observations (informal tools), or could have asked her to come up with her own way of exploring the food chain (informal activity). Another possibility is that Clare could have been asked to come to this type of environment in her own time, in order to undertake the project as a piece of homework (informal environment). If all these changes were made it would radically change the scenario from TNTT to TSSS.

REVIEW OF M-LEARN 2007 SYSTEMS

We went through the proceedings of M-Learn 2007 and placed each of the systems we found into our 4D model of formality. There were forty papers accepted to the conference, but only 17 mobile experiences described (as many of the papers referred to theory, or were themselves reviews or analyses). We do not claim that these 17 systems are representative of mobile learning as a whole, as they describe novel systems, often deployed in experiments or trails (rather than an extended deployment in a real environment). However they are representative of the efforts of the m-learning research community, and indicate the extent of research interest in formal or informal m-learning systems.

The Systems

These systems and experiences are categorized in terms of their general type (e.g. fieldtrip support, or assessment). Several of the systems come from the same paper.

Collaborative learning environment

MOULE system (Arrigo, Giuseppe et al. 2007), *Mobile Jigsaw project* (Thompson and Stewart 2007), *Theory and practice of mobile learning in school project* (Hartnell-Young 2007), *MyArtSpaces system* (Sharples, Lonsdale et al.

2007), *Mobile Blogging* (Cochrane 2007), *StudentPartner system* (Hwang, Hsu et al. 2007), *Mobile Group Blog to support Cultural Learning* (Shao, Crook et al. 2007). All of these aimed to provide students with an interactive learning environment by means of use of social software and mobile functionality such as GPS.

Remote control environment

Remote Laboratory system (Mittal and Gupta 2007) and *Mobile Engineering Laboratory Application* (Mittal, Pande et al. 2007). These systems use a mobile device to control and supervise a remote laboratory.

Language Training

ESL system (Ally, Schafer et al. 2007) and *Mobile phones for language learning project* (Cooney and Keogh 2007) both aim to help the people improve their language ability. The former focused on English grammar and the latter concentrated on listening, speaking, reading and writing of the Irish language.

Assessment

Examination system (So 2007) aimed to assess learners using mobile devices, *MOBI system* (Matthee and Liebenberg 2007) enables formative assessment for Maths on mobile device, and *15/16 Game system* (So 2007) was to test students by means of interaction with other people.

Lifelong learning

Adapt-VLE system (Elson, Reynold et al. 2007) is used to train learners about changes of medical information, and *Museum visiting* (Bressler and Kahr-Hojland 2007) was a spontaneous visiting application (without the requirement of a structured fieldtrip).

Feedback

Voting system was devised (So 2007) to allow students to use their mobile devices to vote on a topic or subject.

Catagorising the Systems according to the 4D Model

System / project	Context				
	LO	**Env'**	**Act**	**Tool**	**Grp**
Voting system (So 2007)	T	T	T	T	**1**
15/16 Game system (So 2007)	T	T	T	T	
MOULE system (Arrigo, Giuseppe et al. 2007)	T	N	T	T	**2**
Mobile phone for language learning (Cooney and Keogh 2007)	T	N	T	T	
Theory and practice of mobile learning in school (Hartnell-Young 2007)	T	N	T	T	
Examination system (So 2007)	T	N	T	T	
Mobile Group Blog to support Cultural Learning (Shao, Crook et al. 2007)	T	S	T	T	**3**
Mobile Jigsaw project (Thompson and Stewart 2007)	T	S	T	T	
Remote Laboratory system (Mittal and Gupta 2007)	T	S	T	T	
ADAPT-VLE system (Elson, Reynold et al. 2007)	T	S	T	T	
Mobile Engineering Laboratory Application (Mittal, Pande et al. 2007)	T	S	T	T	
MOBI system (Matthee and Liebenberg 2007)	T	S	S	T	**4**
Student partner system (Hwang, Hsu et al. 2007)	T	S	S	T	
MyArtSpace system (Sharples, Lonsdale et al. 2007)	T	S	S	T	
ESL project (Ally, Schafer et al. 2007)	S	S	T	T	**5**
Museum visiting (Bressler and Kahr-Hojland 2007)	S	S	S	S	**6**
Mobile Blogging (Cochrane 2007)	S	S	S	S	

Table 1.Systems/projects within the mlearn2007 conference papers

We have used our 4D model to categorise these 17 systems. The results are shown in Table 1 above. We have grouped systems which have the same 4D profile. There are six groups covering the whole table, and we have arranged them so that the most formal group is at the top and the least formal is at the bottom. Student led values are shown in light grey.

Examples of a System in Each Group

Due to space limitations, rather than explain the categorization of all 17 systems, we have chosen instead to describe one system from each group. In each description we have indicated the places the description matches the 4D Model using the simple notion of LO/Env/Act/Tool followed by T/N/S. So for example, we might say "The student uses their PDA on a fieldtrip (**Env:N**)" to indicate that because it is a fieldtrip the *Environment* dimension is *Negotiated*.

Group 1 (TTTT)

15/16 Game System - Students are asked to use a WAP browser on their mobile phones (**Tool:T**) in the classroom (**Env:T**), to participate in a class game called 15/16. The teacher asks a question (**LO:T**) and the students can choose from a multiple choice answer (**Act:T**), the teacher (or another student) then tries to convince the students to change their minds, by giving a plausible explanation for one of the answers (whether it is right or wrong). The Mobile phones send the students answers and any changes to a server, and the teacher can show this to the class to show the number of students who got it right, and those that changed their minds.

Group 2 (TNTT)

MOULE – is a system that allows students to collaborate through a Moodle-type portal in order to communicate and share resources. For example, a lecturer wishes to teach her students about the architecture in a particular square (**LO:T**), she sets up an activity in Moodle that asks students to make notes about particular points of interest (poi) (**Act:T**). A student visits the square and is free to explore the space, and find the poi that have been described (**Env:N**). Once the poi has been found, the student can take a photo using the built in MOULE toolkit (**Tool:T**). One interested twist with this system is that students back in class (**Env:T**) can collaborate with the the students in the field (**Env:N**). Thus MOULE can be used (at least partially) in an informal way (TNTT), but for the student in the classroom it is a more formal experience (TTTT).

Group 3 (TSTT)

Mobile Jigsaw Project – used mobile devices as an enabler for group work. Teachers chose an issue in the children's local area (**LO:T**), and created small groups of children who were given a number of devices with preloaded software, such as digital cameras, and a tablet PC (**Tool:T**). The children then plan their own fieldtrip (**Env:S**), and visit the environment where they work as a team to gather evidence in order to ask science-based questions back at the classroom (**Act:T**).

Group 4 (TSST)

MOBI System – Students use a bespoke MOBI client (**Tool:T**) on their PDAs to access a wide variety of Activities concerned with Maths (**LO:T**). Students can choose which activities they feel might be useful to them (**Act:S**), and undertake those activities whenever and wherever they like (**Env:S**).

Group 5 (SSTT)

ESL Project – uploaded a wide range of grammar exercises to a student's mobile device. At a time or place of their choosing (**Env:S**), the student could choose to test or expand any part of their knowledge of grammar (**LO:S**). They would then take an appropriate pre-loaded exercise (**Act:T**) using a browser on their mobile device (**Tools:T**).

Group 6 (SSSS)

Mobile Blogging – gave an overview of how blogs might be accessed, written and used on a mobile device. In the given scenario a student accesses the blog throughout their day (**Env:S**) on whatever device they have available using a variety of browsers (**Tool:S**), the blog offers them general functionality, allowing them to explore items of interest with their friends (**LO:S**), and supports a wide range of activities such as journaling, mircoblogging, discussion, comments, etc. (**Act: S**).

ANALYSIS AND DISCUSSION

We undertook this study expecting to see that Mobile Devices support informal learning across the 4D Model, however it is clear from our analysis that while the majority of mobile applications have an informal environment (ether where or when the student can use the tool), relatively few are informal in other ways.

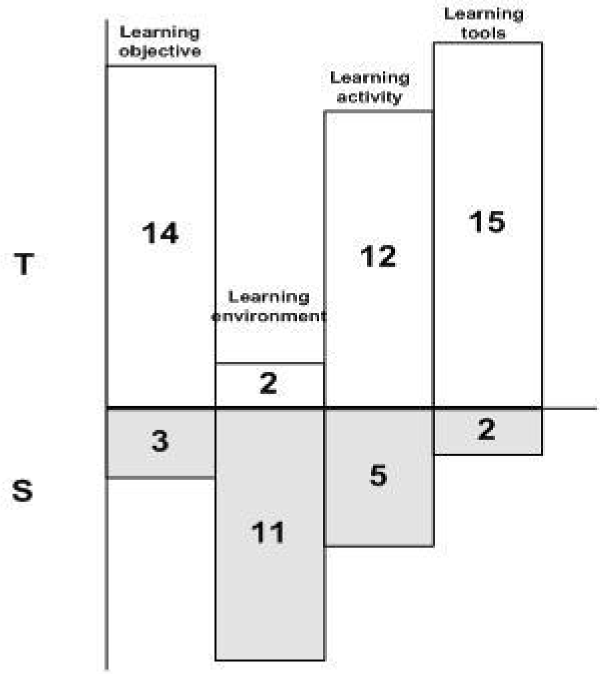

Figure 18. The ratio of T and S for each Dimension

Figure 18 shows the ratio of Teacher-Led to Student-Led in each of the four dimensions (negotiated is not shown in the figure). It clearly shows that Informal Environments are far more frequently supported than Informal Objectives, Activities or Tools.

Partly this may be because our sample was from research papers, where authors are often describing trials of particular tools (so for example, we would expect to see fewer choices for participants regarding which tool they could use). However, it could also be argued that while the data reflects the methods of experiments, it is still valid in that it tells us that there are few mobile experiments being conducted where users *do* have a choice of tools. In effect, while mobile learning claims to be conducive to informal learning – only a very restricted type of informality is currently being explored by the research community.

Figure 19 compiles the data from Table 1 into a matrix that shows the four dimensions (a 3x3 grid of 3x3 grids). We have shaded each cell of the matrix to reflect the overall level of informality of that cell, the darker the cell the more informal it is (so TTTT is white, SSSS is almost black, and TTSS and SSTT are the same shade of grey. The number of systems in a given cell is shown in a white circle over that cell. In effect this diagram shows a map of informality in the surveyed systems. From this diagram it is clear that whole areas of possibility are not being explored, in particular *Negotiated Learning Objectives* (such as placement study), *and Informal Learning Objectives* in *Formal Settings* (such as project work in school).

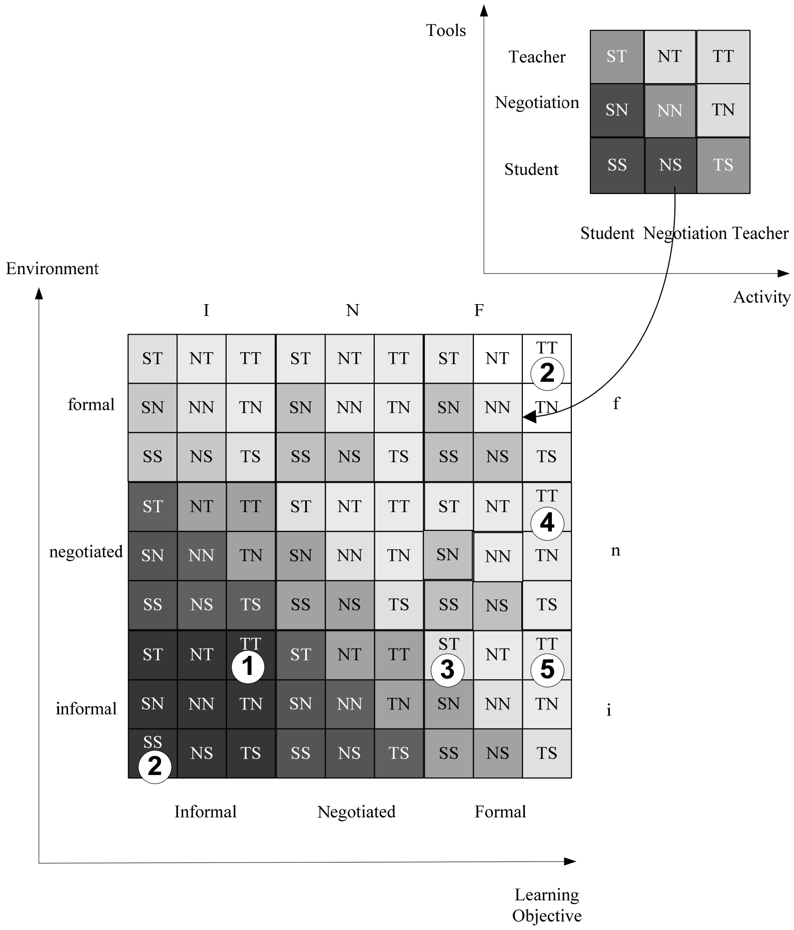

Figure 19: The Landscape of Informality in Our Study

As a whole, our study shows that in mobile learning research systems, teachers are more likely to take control of learning objectives, activities and tools but less likely to control the student's environment. This seems to be because mobile learning research focuses on the geographic mobility of devices (rather than their ubiquity, or any sense of student ownership and thus potential control).

CONCLUSION

In this paper, we set out to explore whether m-learning systems and applications tended to be in the style of Virtual Learning Environments (VLEs) or Personal Learning Environments (PLEs). We concluded that the major factor was the formality of the learning, as PLEs support a range of informal activities, but VLEs tend to support more traditional formal activities.

To undertake an analysis of systems presented at m-learn 2007, we first had to come up with a framework for formal and informal learning, which would allow us to distinguish between the different types of formality. We have thus presented the *4D model of formal learning*, which looks at four factors within an experience to see if they are student or teacher led (Learning Objective, Learning Environment, Learning Activity and Learning Tools).

We characterised each of the 17 systems presented in m-learn 2007 using our framework and have discovered that while most are informal in terms of their environment (where and when they can be used), most are formal in all the other terms – so for example, students rarely get to choose their own learning objectives or the methods that they will use to achieve them.

It therefore seems that although m-learning applications seem well placed to become part of a student's PLE, little research is being undertaken to understand how they could be used in this way. In essence m-learning researchers are reinventing the VLE on the mobile device, rather than looking at how we could use them to support more subtle aspects of informal learning, and thus the increasingly important PLE area.

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Designing Mobile Learning Environments: Mobile Trials at Unitec 2008.

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ABSTRACT
This paper outlines the progress of mobile learning trials currently being undertaken at Unitec. These trials are the second stage in an action research process, following on from the first mobile learning trial at Unitec in 2007. The 2008 mobile trials are informed by the results and experiences of the first trial in 2007. An outline of the three trials and their progress is provided, along with an overview of the design and support structures being utilised. The three trials follow a common design and support process, with tutor and student support utilising principles from a communities of practice model, and are based on an explicit social constructivist pedagogy. The trials are based in three different teaching and learning contexts utilising three different mobile device platforms. Thus the trials are designed to explore the transferability of the concepts and identify common critical success factors. The trials explore the potential of mobile web 2 tools to enhance teaching and learning, in particular mobile blogging (moblogging). Outcomes of the trials will be published at the end of the academic year.

Author Keywords
Mobile, Social Constructivism, web 2, moblogging, action research, communities of practice.

INTRODUCTION
The main focus of this project is on the support and enhancement of face to face teaching and learning by using wireless mobile devices (WMDs or smartphones) as a means to leverage the potential of current and emerging collaborative and reflective e-learning tools (e.g. blogs, wikis, RSS, instant messaging, podcasting, social book marking, etc…). These are often called “social software” or web 2 tools. The project links the use of freely available mobile friendly web 2 tools accessed via a smartphone with the learning objectives of a variety of different tertiary education courses. The smartphone’s wireless connectivity and data gathering abilities (e.g. photoblogging, video recording, voice recording, and text input) allow for bridging the on and off campus learning contexts – facilitating “real world learning”. The research is focusing on social constructivist approaches to education (Bijker *et al.*, 1987; Lave & Wenger, 1991; Vygotsky, 1978; Wenger *et al.*, 2002) and a conversational model (Laurillard, 2001, 2007) of teaching and learning. The disruptive nature of Web 2 and mobile technologies (Sharples, 2000, 2001, 2005; Stead, 2006) facilitates a move from instructivist pedagogies to social constructivist pedagogies. The personal, social networking, and context awareness of mobile devices democratise power relationships and are best suited to open learning environments. Disruptive technologies are those technologies that challenge established systems and thinking, requiring change and are thus viewed by many as a threat to the status quo. Disruptive technologies democratise education environments challenging the established power relations between teachers and students. Mishra et al (2007) argue that “appropriate use of technology in teaching requires the thoughtful integration of content, pedagogy, and technology”.

> The addition of a new technology reconstructs the dynamic equilibrium between all three elements forcing instructors to develop new representations of content and new pedagogical strategies that exploit the affordances (and overcome the constraints) of this new medium. Similarly, changing pedagogical strategies (say moving from a lecture to a discussion format) necessarily requires rethinking the manner in which content is represented, as well as the technologies used to support it" (Mishra et al., 2007).

Definitions of mobile learning have focused upon the mobility of the devices and the learners. Sharples proposes a form of Laurillard’s conversational framework, excluding the teacher, to define mobile learning by its contextual and informal learning characteristics. “The processes of coming to know through conversations across multiple contexts amongst people and personal interactive technologies” (Sharples *et al.*, 2006). However, a key element in the conversational framework is the dialogue between teacher & student. In contrast to Sharples et al (2006), Laurillard (2007) emphasizes the teacher’s input in mobile environments through good pedagogic design that facilities continuity between the face to face and remote peer learning contexts. Her definition of mobile learning incorporates the critical pedagogical design input of the teacher: “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).

Mobile trials

This paper reports on the progress of several qualitative action learning trials being run to investigate the impact of WMDs on teaching and learning in higher education. The anticipated learning outcomes of these trials for students are:

i. Developing critical reflective skills
ii. Facilitating group communication
iii. Developing an online eportfolio
iv. Developing a potentially world-wide peer support and critique network
v. Learning how to maximise technology to enhance the learning environment across multiple contexts

The 2008 trials build on critical success and limitations identified in the first mobile trial in 2007. The first trial began in February 2007, with Diploma Landscape Design students implementing the use of Blogs, online image sharing, eportfolios and RSS (Rich Site Summary or Really Simple Syndication) aggregation to create a collaborative team-based project design for the Ellerslie International Flower Show (November 2007). With research funding made available in July 2007, students were provided with Nokia N80 smartphones to post to their Blogs and upload photos and videos to their online eportfolios via 3G (Third Generation cellphone data) or WiFi (802.11a/b/g/n wireless Ethernet) networks. This provided students with a flexible collaborative and context-sensitive elearning environment with which to document their Flower show projects. The first trial (Diploma Landscape Design 2007) provided a basis for informing the second trial (Bachelor of Product Design 2008). A full report of the first trial can be found on Google Docs (Cochrane, 2007a, 2008a, 2008b). The first trial highlighted the disruptive nature of mobile learning technologies, and their potential to move teachers and learners from an instructivist to a social constructivist pedagogy. The following trials attempt to better scaffold this pedagogical change and address the key technological shortcomings highlighted in the first trial. Critical success factors identified in trial one included:

i. Introducing the mobile devices at the beginning of the trial
ii. Getting academic staff on board early
iii. Clearly identifying course integration and goals
iv. Providing suitable text entry facilities (Bluetooth keyboard or handwriting recognition touch screen device)
v. Providing both WiFi and 3G data access for ubiquitous connectivity

Students and teaching staff are provided with a 3G smartphone with a 1GB/month mobile broadband account plus a personal voice account (Students are responsible for paying for voice calls and txt messages, while the 1GB data plan costs are reimbursed by the project) for the duration of the trial (2008). Internet connectivity is also available via the Unitec WiFi network while on campus. This provides faster, free web access while on campus. As the previous trial in 2007 indicated that the limitations of text entry on the smartphones was significant in hindering student reflection, participants in the 2008 trial are also provided with a folding Bluetooth keyboard that can be paired to their smartphone. Also student interaction and collaboration were significantly increased by switching from Wordpress (Automattic Inc, 2007) to Vox blogs (Six Apart Ltd, 2007), therefore Vox is used as the blog/eportfolio host of choice from the beginning of trial2.

Smartphone selection

The choice of mobile device for each trial is based on the best fit of features with the key requirements of each course. Previous trials identified the importance of a ubiquitous connection to the Internet for student productivity across multiple contexts, and the preference of students and tutors to carry a single device (i.e. a cellphone); hence preference was given to smartphones over WiFi capable PDAs (Personal Digital Assistants). Common specifications required include: WiFi capability for free web access while on campus, 3G for fast web access off campus, a built-in camera, media playback, multitasking operating system for instant messaging capability, alternative text entry capability, support for key web 2 applications. Windows Mobile devices were not considered based on their small marketshare, instability, and inherent 'uncoolness' for students. Palm smartphones had been trialed initially in 2007 but had been rejected by students because of the poor quality of the built-in camera, 'clunky' form-factor, and aging OS (Operating System). Budget was another factor, limiting the cost of the device to $700NZ each. To keep the cost of the devices down, the smartphones were purchased 'unlocked' through parallel importers.

Communities of Practice

The tutors involved in the trials have previously been involved in the development of academic peer support groups guided by a teaching and learning professional, i.e. an intentional Community Of Practice (Cochrane, 2007b; Cochrane & Kligyte, 2007), investigating the use of Web 2 social software tools and then mobile learning in education. This Community of Practice also provides a model for academics to use in their own student classes as they later integrate social software and mobile technologies into their courses. The project is guided and supported by weekly "technology sessions" facilitated by a 'technology steward' (Wenger et al., 2005) who is the researcher and an Academic Advisor in elearning and learning technologies in the Centre for Teaching and Learning Innovation (CTLI) at Unitec. The projects are collaborative projects between the 'technology steward', the course tutors, and the students on the course.

Support

As part of the role of the 'technology steward' for the trials the researcher has also taken on developing the technical and learning support for the trials. This has involved the investigation and purchase of appropriate smartphones and folding Bluetooth keyboards for the smartphones. The best option for providing voice and data connectivity for the trial participants (within the project budget) was investigated with Vodafone New Zealand. The smartphones were pre-configured with the wireless settings and software appropriate for the trial (e.g. Vox client, GMail client, Shozu client, Google Mobile and Moodle shortcuts etc…). Tutorial courses have been created for each trial within the Learning Management System (LMS) used by the course (either Moodle or Blackboard). Demonstration tutorials have been created using screen captures of the smartphones accessing the various web 2 tools utilized and embedded as interactive slideshows within the LMS. Support has been provided for the course tutors in the form of pre-trial tutorials on using the smartphone and web 2 tools. Finally the core support element of the trials is a weekly 'community of practice' investigating the use and integration of the smartphones and web 2 tools involving: the technology steward, the course tutors, and the students. Each trial 'learning community' is also supported by the 'neighbourhood' social networking feature of Vox, and the use of instant messaging for facilitating communication and a sense of social presence.

Research Questions:

1. What are the key factors in integrating Wireless Mobile Devices (WMDs) within tertiary education courses?
2. What challenges/advantages to established pedagogies do these disruptive technologies present?
3. To what extent can these WMDs be utilized to support learner interactivity, collaboration, communication, reflection and interest, and thus provide pedagogically rich learning environments that engage and motivate the learner? To what extent can WMDs be used to harness the potential of current and emerging social constructivist e-learning tools?

Data gathering consists of:

1. Pre-trial surveys of lecturers and students, to establish current practice and expertise
2. Post-trial surveys and focus groups, to measure the impact of the wireless mobile computing environment, and the implementation of the guidelines.
3. Lecturer and student reflections via their own blogs during the trial.

Pedagogical Design

The core activity of the project is the creation and maintenance of a reflective Blog as part of a course group project. Additionally a variety of mobile friendly web 2 tools are used in conjunction with the smartphone. The trials investigate how the smartphone can be used to enhance almost any aspect of the course. The project uses the smartphone and Personal Computers for the following activities (see the following table illustrating the alignment of these activities with the projects underlying social constructivist pedagogy - there is an interactive online version available at http://ltxserver.unitec.ac.nz/~thom/mobileweb2concept2.htm):

Activity	Overview	Pedagogical outcomes
A reflective Blog	A blog post (including media) can be uploaded directly to VOX using the Vox client on Nokia smartphones, or Shozu (http://www.shozu.com), or emailed to VOX xxxxxx@moblog.vox.com	Developing critical and reflective thinking
An eportfolio	VOX (http://www.vox.com) includes media sharing (video, audio, documents, images, links…) and linking (YouTube, Flickr etc…) as well as social networking.	Collaborative sharing of media and peer critique, also forms the basis for a career portfolio.
Email	GMail (http://gmail.com) provides a free email account that can be used on almost any Internet capable device. A GMail account also opens free access	Communication and collaboration

	to all other Google web services. The Google Java application optimises GMail for phones.	
RSS	RSS enables subscribing and tracking/sharing of online activity. It provides a link between all your web 2 media sites. Google reader (http://reader.google.com) is a great web based RSS reader, while Newsgator (http://www.newsgator.com) also provides RSS clients for synchronisation via PC, Mac or mobile.	Collaboration
Shared Calendars	Google Calendars (http://calendar.google.com) can be shared between groups of people via invitation. Google Calendars use an open format that provides interoperability between many calendar systems – e.g. iCal on Mac OSX	Time scheduling and collaboration of activities
Image Blogging	Dedicated image sharing repositories such as Flickr and picasaweb offer more interactive features than Vox's image repository, and are linkable to Vox and other Blogging systems. Direct mobile upload to Flickr can be achieved via either the Vox client, or email. Picasaweb mobile is supported via Shozu destination uploads.	Event, data and resource capturing and collaboration. Creativity.
Video Blogging	YouTube (http://www.youtube.com) is currently the most popular video-sharing site. The mobile version supports viewing of videos online in the mobiles web browser, or via a downloadable Java client for specific phones. Uploading mobile videos to YouTube is achieved via email attachments.	Event, data and resource capturing and collaboration. Creativity.
Shozu	Shozu is a service for linking all your online mobile Blog and Media sites together via either the Shozu client application, or an email sent to go@m.shozu.com	Shozu provides links between all the pedagogies described.
Podcasting	Uploading an audio file to Vox creates a podcast episode that others can subscribe to via an automatically created RSS feed.	Interviews, critiques, reflections, shared collaboration.
Instant Messaging and Skype	Fring (http://www.fring.com) is a free Instant Messaging and Skype client for most mobile phones. It allows messaging between the most popular IM systems. It works best over a WiFi connection, or good 3G connection.	Communication and collaboration
Shared Bookmarks	Delicious (http://del.icio.us) is a social bookmarking site – allowing the creation and sharing of Internet bookmark libraries and searching via tags (descriptive keywords). Mobilicious (http://mobilicio.us) a mobile optimised version.	Collaboration
LMS	Moodle is a mobile friendly Learning Management System, hosted on a production level Unitec server. Course notes, discussion forums, and various activities can be hosted on Moodle.	Scaffolding and support
Mobile Google	A gateway into the Google Mobile services (http://mobile.google.com) via the phones web browser. iGoogle (http://www.google.com/ig/i) is a customisable mobile Google Homepage.	Links to tools that support all of the mentioned pedagogies.
Mobile Codes	Mobile Codes (Datamatrix codes in this case) provide sharing of URLs, text and messages via scanning using the smartphones built-in camera. Codes can be created and downloaded from http://mobilecodes.nokia.com and scanned using either a compatible scanning application on the mobile phone.	Scaffolding, support, collaboration.
Web Browsing	The Built-in Web Browser is very good, but in some cases Opera Mini may work better, and Opera Mini has several tools built-in (RSS feeds, synchronisation with Opera on a PC etc…)	Research skills
Document Reading & Editing	Google Docs (http://docs.google.com) is Microsoft Word, Excel and PowerPoint compatible. Documents can be uploaded and shared and edited by a group. They are viewable online in a web browser without MS Office. Docs can be created on mobile devices by emailing the document to a private Google Docs address. To edit uploaded documents you need a full PC web browser, or a full version of 'QuickOffice' on your smartphone – a mobile version of MS Office (~ $60).	Documentation, reflection, critique, description, and collaborative document publishing etc…

Table 1. Table of trial activities aligned to social constructivist pedagogical outcomes.

2008 TRIALS

The following sections outline the current three mobile learning trials. Although each trial has a specific project focus, the trials are exploring how a mix of mobile web 2 tools can enhance the student's learning throughout their whole course. Each trial uses a Learning Management System (LMS) to provide scaffolding and support for both tutors and students. Each project also uses a different 'smartphone' device, appropriate to the requirements of the course, and each project has a specific timeline that has been negotiated between the course tutors and the researcher. The timeframe of the trials was designed to firstly familiarise the tutors with the tools and technology before introducing it to their students. Semester one goals are mainly to get tutors and students experimenting and confident with the tools, embedding them into their course workflows, followed by more explicitly targeted pedagogically designed learning experiences in semester two.

Bachelor of Design (Product)

Starting in February 2008, the focus of this trial is the development of group product design teams formed between the students and external client product manufacturers. Students must develop a commercially viable product for their assigned client. Student blogs and eportfolios are used to record and reflect on their design processes, and are made available to the client for comment and interaction. Students and staff were initially supplied with a Nokia N80 WiFi/3G smartphone and folding Bluetooth keyboard, which was later upgraded to a Nokia N95 smartphone. Students use the smartphone for recording and uploading evidence of their design process and prototypes to their VOX blog and other online media sites such as YouTube for video. Students are marked on this evidence of the design process and reflection, as well as their critique and reflection on other students' blogs via commenting. The smartphones are also used as a communication tool between students and with teaching staff for immediate feedback via instant messaging, email and RSS subscriptions.

Participants:

i. 8 students (two teams of 4) – students volunteer to participate in the trial using the provided smartphone. The average age of the students is 24, and the gender mix is 1 female student and 7 male students.

ii. 2 Course Tutors

iii. Technology Steward (Thom Cochrane – CTLI)

Below is a generic timeline developed for the 2008 trials, based upon supporting the critical issues identified in the 2007 trial:

Project Steps	Project Milestones
1. Pre trial	v. Brainstorm project goals and course integration with course Tutors
2. Pre trial	v. Purchase folding Bluetooth keyboards for smartphones i. Investigate best option for providing voice and data connectivity i. Configure the smartphones with software appropriate for the trial (e.g. Vox client, GMail client, Shozu client, Google Mobile and Moodle shortcuts etc…) i. Setup Moodle support course
3. Pre including students in trial	x. Provide course tutors with smartphone and tutorials on setup.
4. Trial setup with students	x. Blog and Web2 setup session with Students and Staff
5. Trial official start with students	i. Provide students with smartphone and begin weekly technology support sessions.
6. On going, weekly throughout trial	i. Support students and staff during trial via weekly 'technology workshops' i. Monitor student progress via their Vox Blogs/eportfolios
7. Mid trial and end of trial	v. Student and staff surveys v. Focus group i. Data analysis and report write up. i. Re-evaluation of Trial for second semester
8. End of trial	i. Final Data gathering, analysis, and report write up.

Table 2. Typical Trial Process and Timeline.

Diploma of Contemporary Music

Starting in February 2008, this trial is centred on the music technology paper that is part of the Diploma of Contemporary Music. Students experiment with and evaluate current music creation and delivery technologies, including podcasting and sharing via blogs, eportfolios, and social networking. For semester one of the trial tutors and students have been provided with an iPod Touch (16GB) each, which will be replaced by a 3G iPhone in semester two when they become officially released in New Zealand. While the iPod Touch is not a smartphone, it has WiFi and is essentially an iPhone without the phone or camera capability, thus it provides a limited connectivity version of the iPhone until they are available. The iPod/iPhone includes a virtual keyboard for text entry as part of its touch-screen interface. Blackboard was used as the Learning Management System for providing tutorial support for the project. The Trial is initially examining how the iPod Touch can be used as a communication and collaboration tool between students and staff (using email and instant messaging) and as a tool for accessing, editing and commenting on their online blogs and media eportfolios. In semester two, the iPods/iPhones will be integrated into the course delivery and assessment as part of a PODcast and VODcast sharing project with another similar course at another New Zealand institution. This will include elements of peer critique and review recorded on their VOX blogs.

Participants:

- 11 students – students volunteer to participate in the trial using the provided iPod Touch. The average age of the students is 22, and the gender mix is 6 female student and 5 male students.
- 2 Course Tutors
- Technology Steward (Thom Cochrane – CTLI)

Diploma of Landscape Design

This trial has a focus on an elective experiential trip to Japan in September 2008 and is set to start in semester two 2008. The students are required to create a reflective journal of their trip and it's influence on landscape design ideas in New Zealand. Because of the expense involved in the Japan trip, the average age of the class is much higher (55) than the other trials, as the younger students cannot afford the extra cost of the trip. Participants are provided with a SonyEricsson P1i smartphone plus Bluetooth folding keyboard for text entry. Moodle is used as the support Learning Management System for this trial. The smartphones will be used to record, upload and comment on photos and video of their landscape design projects, including sourcing plants and ideas while off campus, and in Japan. The smartphones are also used for communication and collaboration via email, instant messaging, and RSS subscriptions to each other's blogs.

Participants:

- 8 students (two teams of 4) – students volunteer to participate in the trial using the provided smartphone. The average age of the students is 55, and the gender mix is 6 female student and 2 male students.
- 2 Course Tutors
- Technology Steward (Thom Cochrane – CTLI)

DISCUSSION

The three 2008 mobile learning trials are still in early days, but good progress is being made. The amount of support required to initiate and nurture the three groups of students and tutors has been more than was envisioned. Nurturing successful intentional Communities of Practice requires significant time and effort (Langelier, 2005; Wenger et al., 2002). However this has been minimised by having a common design to the three trials that has been developed from the experiences of mobile and web 2 projects over the past three years. The partnership between the researcher and the three groups of tutors has been built-up over this period as well - initially through communities of practice investigating the use of educational technology, and now this model is being loosely used to create learning communities consisting of the researcher, tutors, and their students. The challenges include modeling the pedagogical use of the technology to the students, and making the learning outcomes explicit for the students while allowing the flexibility for each group to creatively experiment and develop uniquely.

Using an action research methodology for the trials provides the flexibility to critique, reflect on, and modify the projects as required.

The 2008 trials have built upon the foundation laid by the first mobile trial in 2007 (Cochrane, 2007a, 2008a, 2008b), which found that:

- A context spanning social-constructivist learning environment is facilitated.
- Teachers require a new pedagogical toolkit to capitalise on this environment.
- Students require explicit scaffolding in this environment.
- The capabilities of affordable smartphones are constantly increasing, as is the availability of free mobile Web2 services. These can be matched to create highly collaborative and motivating learning environments.
- Good pedagogical design of contextual learning environments is essential.
- Tutor professional development and technology support is critical.
- An ethos of the educational use of mobile web2 technologies needs to be developed within the teaching and learning environment.

- Technology support for students is critical and must be integrated early into the course.
- Student preferences must be considered when choosing appropriate wireless mobile devices.
- Significant time is required to develop skills in the use of the technologies for both students and tutor

Feedback from the 2008 trials has so far been very positive. While initially finding learning the smartphone interface and variety of web 2 sites/tools daunting, students integrated their use into their everyday lives. Access to online media has been significantly increased by the addition of a 1GB per month 3G data plan for each member. While the 2007 trial participants were limited to WiFi access and pay-as-you-go 3G data (which was far too expensive to utilize), the 2008 participants have found 3G data to be significantly faster than the institutions WiFi network. This has led to a significant increase in the use of real-time multimedia on the smartphones. Students particularly valued the ability to capture and record ideas and content using the smartphones multimedia capabilities (Cochrane & Bateman, 2008b). They uploaded significantly more media (Mainly still images) to their online eportfolios than actual blog posts. There is evidence of careful selection of the media that students finally add into their blog posts for display and commenting. Several students preferred to VODCast (record and upload a video monologue) rather than post text based reflections on their blogs. The ability to make video demonstrations of design prototypes and upload these to either VOX or YouTube was particularly utilized by the Landscape Design and Product Design students. Unfortunately the iPod Touch does not incorporate a camera, and the iPhone is currently incapable of recording video, however Diploma Contemporary Music students have uploaded still photos of their performances. Watching YouTube videos on their mobile devices is a popular activity, especially with the N95 and iPod Touch which support video out to a large screen or video projector. Least valued by students was the ability to access course content on the smartphones. This is a reflection on the underlying pedagogy chosen for the trials (Social constructivism) where a conscious decision was made to focus on communication, collaboration and user generated content rather than repurpose course content for small screens. Students who own laptops have used the smartphones to complement their use of their laptops, and in some instances replaced the use of their laptop with their smartphone while traveling. Although a small number of the 2007 Diploma Landscape Design students rejected the idea of purchasing their own smartphone, the 2008 Bachelor of Design and Diploma Contemporary Music students were unanimous in indicating they would purchase their own smartphone. The second Diploma Landscape Design project is set to start in semester two 2008.

When asked in what situations the WMDs were most effective, students replied

> As a mobile computer – instead of a laptop, and as a communication tool for a team who are in different places all the time, too busy to meet, to transfer information, pictures, documents etc. (Diploma Landscape Design student 2007)
>
> Spur of the moment, spotting something inspirational, documenting an idea when a PC is not around. (Bachelor of Product Design student 2008)
>
> It's the convenience of the small device, nice and handy fits into the pocket. No matter where I was I could use it, spare time having lunch, toilet, even in the classroom while the teacher wanted some information about a particular person. At school looking for information on the net, leisure times, looking at other classmates' webpage's, blog and youtube videos etc… (Diploma Contemporary Music student 2008).

While integration into the courses required significant rethinking of staff pedagogies and assessment procedures, all the staff involved in the trials were very positive at the results (Cochrane & Bateman, 2008a; Cochrane & Cliffin, 2007).

> Once I learnt how to use the technology I then moved on to be able to work with the students. I modified an elective exercise that we didn't formally teach, but was an opportunity for students to put their studies into practice by creating a design for the Ellerslie Flower Show. We decided to make it a course, that doesn't have to have content, but a process, synthesizing all aspects of their Landscape Design course and we can bring in all these learning technologies to support it, including blogs, wikis, and an eportfolio instead of presenting it the traditional way. So in 2006 we trialed it and have built on the idea since then. Thom helped us along the way with this... The Community of Practice that was fostered and the new skills that the students gained in the e-world were fantastic and contributed to them doing so well. It's been a great success and we get savvier every year continuing to experiment with new technologies. Students are feeling more satisfied with the capabilities of the tools they are using and I'm going to keep learning too! (Diploma Landscape Design staff 2007)
>
> It isn't 'easy' working in this way but it is immensely valuable and exciting. I think that it would be very hard to go back to traditional teaching only methods now I have begun to use blogging and mobile blogging. (Bachelor of Product Design staff 2008)
>
> WMDs are very effective for motivated students who need to communicate for group projects.
>
> I would now be better able to integrate the WMD into assignments rather better. (Diploma Contemporary Music staff 2008).

The final results of the current three trials will be evaluated and reported upon at the end of 2008.

CONCLUSIONS

The mobile web 2 trials have been designed using explicit social constructivist pedagogy, with freely available web 2 tools being integrated into three different courses. Flexible multi-contextual learning environments are being facilitated, and the technology steward is supporting the tutors involved in the three trials in their discovery of new pedagogical toolkits. Using an intentional Communities of Practice model to form a strategic element in the support structures for the trials is proving successful, but it is yet to be seen whether it can be sustained in the longer term. It is hoped that the potential success of the trials will lead to further uptake and integration within the institution, and provide valuable insights for the growing international mlearning community.

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Supporting Location-based Inquiry Learning Across School, Field and Home Contexts

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ABSTRACT
Here we explore how technology can be applied to support inquiry learning spanning a range of contexts. The development process of a location-based inquiry learning toolset is presented for a secondary school GCSE Geography project. The design framework used and the process of participatory development is discussed with regard to the co-development of the activities and tools involved in an inquiry project. The lessons learned relate to the formation of a motivational context for the inquiry; the role of personal data collection in the field; the use of bridging representations across field and classroom activities; and the development of flexible, re-usable tools to support and bridge sequences of activities.

Author Keywords
Inquiry learning; motivational context; sequencing activities; investigation tools; process support; participatory design; incremental and iterative development.

INTRODUCTION
This paper describes the development of a location-based inquiry learning toolset to support an eight week GCSE Geography project, which has been completed by 78 students in a UK secondary school. The paper discusses the process with regard to the design of technology-supported inquiry activities, and the use of mobile and web technologies to bridge learning contexts. This work was carried out as part of the Personal Inquiry (PI) project, a three year Technology Enhanced Learning project funded by the UK's Teaching and Learning Research Programme. The aim of the project is to understand how effective learning can be enabled with technology between formal and informal settings, such as in school, on field trips and at home.

One of the challenges of educational fieldwork is to incorporate the skills and knowledge acquired in the field with those in the classroom and other learning contexts. To address this problem we are exploring the potential of mobile technologies that can be used persistently across these contexts and the application of a scripting approach to inquiry learning to help direct the students' activities towards the attainment of their learning objectives. A five stage process of scientific inquiry was used in this case, consisting of the question, methodology, data collection, analysis and conclusions. Extensive use of ICT was made across all stages of the inquiry: the students used the web to research the inquiry topic, and a range of Office applications were used to write up each stage of the project in the form of a report. A web-based application was developed to support the data collection and analysis stages of the inquiry. An Ultra Mobile Personal Computer (UMPC) was used to record data during the data collection activity on a one-day fieldtrip, and these were also available for loan to the students for the remainder of the project. Through the combined use of the web-based application, the loan computers and a set of USB memory sticks, the students were able to access their data and work on their project in a consistent way, both at school and at home.

BACKGROUND
Inquiry learning can be an effective form of tuition for acquiring intuitive, deep, conceptual knowledge (de Jong, 2006). While recognising that a balanced form of instruction is needed, inquiry learning across the school curriculum is becoming a widely recommended approach. For example, in a recent report on the standards of Geography education in primary and secondary schools in the UK, the government's educational standards group noted that "enquiry-based fieldwork sharpens and deepens learners' understanding of geography and the progressive development of geographical skills, both in situ and in the lessons in school related to it" (Ofsted, 2008, p. 34).

Location-based inquiry learning across school, field and home contexts is a form of learning in which the learner is mobile and therefore has a pragmatic need for appropriate technology to support their learning activities (Sharples, Taylor, & Vavoula, 2007). A range of research projects have explored the potential of mobile technologies for supporting learning (for a series of case studies, see Naismith, Lonsdale, Vavoula, & Sharples, 2004). Of direct relevance to this work are the Ambient Wood (Rogers et al., 2004), Mobilearn (O'Malley et al., 2003) and Participate (http://www.participateschools.co.uk last accessed April 2008) projects. Ambient Wood investigated the design, delivery and interaction of digital information for learning about ecology outdoors, thereby providing an applicable set of guidelines for the PI project. Mobilearn was concerned with the development of context-aware mobile devices, for delivering content and services to mobile learners. Finally, the Participate project is exploring the three strands of schools, community and games for developing web-based support for school education. Through collaborating with schools this project is developing a series of collaborative mobile and web technologies for use in schools.

APPROACH

We have adopted a participatory design approach on the PI project. Working in partnership with the teachers we have developed a set of learning activities and support tools around a specific topic. Recommendations and feedback were also given periodically during the development process by our collaborators at ScienceScope, a company involved in producing sensing and data logging equipment for science education.

In early meetings we explained the goals of the project and the type of technologies that we were interested in exploring. In discussing potential topics, one of the teachers proposed to investigate urban heat islands and suggested that they could run an inquiry project for the GCSE coursework. Having agreed the context, we then discussed the design of the activities and the supporting tools and resources. A series of paper prototypes and sample datasets were used to inform the development of the activities and tools. In the course of developing our ideas we decided to collect a set of temperature and environmental data across Milton Keynes. From the advice of ScienceScope we measured air temperature, carbon monoxide, wind speed and infrared irradiance. In the course of developing the activity we extended the fieldwork to cover two towns, in order to collect a second dataset that would encourage the students to draw comparisons.

The year 10 GCSE Geography group is made up of three classes, and for logistical reasons the three classes were split into two groups, which carried out the same fieldwork activities on two successive days. During their fieldtrip the students worked in self-selected groups. Although the topic and parameters of the inquiry were determined by the teachers, the students were encouraged to develop their hypotheses, research the topic independently, and work individually to analyse the data they collected by relating it to the data collected by other student groups across the two days, and to a further sample dataset collected by the researchers.

The participatory design process began in October 2007. The students started their coursework project in mid February and the submission deadline for their completed reports was at the beginning of April. Through developing support for a specific application we are interested in identifying aspects of the activities and support tools that may generalise and apply to other situations. Within the urban heat island project we were interested in collecting data at specific locations. Therefore, we started from the perspective of developing a support tool for location-based inquiry learning where the location or position of each data point was a defining characteristic of the study. With this in mind we produced a customisable tool that could be tailored to forms of inquiry involving comparisons made across locations.

DESIGN

Five challenges for implementing inquiry-based learning have been identified by Edelson, Gordin and Pea (1999), namely: motivation, accessibility of the investigation technique, background knowledge, management of extended activities, and practical constraints of the learning context. As noted by Edelson et al. (1999) the students' motivation to engage with the activity and the accessibility of the investigation techniques (e.g. their ability to master the techniques and tools used for data collection and analysis) are common challenges also identified in Learner-Centered Design (Soloway, Guzdial, & Hay, 1994). The students' level of background knowledge and their knowledge of investigation techniques needs to be sufficient to provide the basis for a meaningful investigation. The self-regulation required in managing their activities can be difficult for learners without experience in this form of activity (Manlove, Lazonder, & Jong, 2006). Finally, the practical constraints, such as the time and resources available to complete a task or the assessment criteria will affect the nature of the inquiry.

In response to these challenges Edelson et al. (1999) proposed a design framework for technology-supported inquiry learning based on the coordination of the following four interdependent components: "the motivational context, the selection of sequencing activities, the design of investigation tools, and the creation of process supports" (ibid, p. 440). The remainder of this section describes each of these four components for the urban heat island project.

Motivational context

Strategies for selecting a motivational context for learners relate to identifying meaningful, controversial and open issues (Blumenfeld et al., 1991) (Dillenbourg & Schneider, 1995) (Barron et al., 1998). The chosen topic in our case was microclimates and in particular the formation of urban heat islands. This is a metropolitan area that is significantly warmer than its surroundings (http://www.bbc.co.uk/weather/features/understanding/urban_heat_islands.shtml last accessed April 2008). The reported studies of urban heat islands are typically from major cities, such as New York, Tokyo, and London. Explaining this phenomenon requires an understanding of the thermal radiation from buildings; the effect of the geometric properties of buildings on the reflection and absorption of sunlight and cooling by convection due to wind blocking; and the influence of pollution on the radiative properties of the atmosphere. By drawing a comparison between the students' home town of Milton Keynes and Northampton, a neighbouring town, the context became meaningful to the students and engaged a sense of competition. Milton Keynes is particularly interesting to investigate as the central business district has a much lower building density than more traditional towns. This was a legitimate inquiry in that the students (and teachers) did not know if an urban heat island occurred in either of the two towns investigated.

Sequencing activities

Staging and bridging activities are intended to scaffold the students' learning to ensure their knowledge builds through the course of the inquiry process. This component of the design framework specifically targets the challenges of motivation, the accessibility of the investigation technique, and the underpinning of the students' background knowledge. The sequence of the main activities within the project was as follows.

1. **Topic introduction**: The students were introduced to the topic of urban heat islands by the teachers in the classroom and explicit links were made to the topics previously covered by the students. It was made clear to the students that this project would be the basis for the GCSE coursework (constituting 25% of their overall mark). [Week 1]
2. **Background research and hypothesis**: Primed with a set of relevant websites the students undertook their own research to explore the topic and inform their inquiry. One teacher directed the students to form their own hypothesis from their research, the other gave the students a project title and asked them to research that topic. [Week 1]
3. **Methodology specification**: For each type of data they were collecting, the students completed a table stating why they were collecting that data, what equipment they were using, how they intend to check the accuracy and reliability of the data, how often they were collecting the data, and the measurement units used. [Weeks 2 and 3]
4. **Student coursework introduction**: Prior to collecting their data the students drafted the introductory section of the coursework report, introducing the topic, their question/hypothesis and methodology. These were submitted to the teachers, who marked them and gave the students feedback. [Weeks 2 and 3]
5. **Practice data collection**: In a lesson, a week before they went on the fieldtrip, the students were given an overview of the web application they would use to collect their data (in the classroom), a thirty minute practice session using the equipment (in the school grounds), and a summary relating the data collection tools to their methodology specification (back in the classroom). [Week 3]
6. **Data collection fieldtrip**: On a one day fieldtrip the two teachers and half of the students, working in groups of four or five, walked a two mile route (i.e. transect) across the centre of each of the two towns collecting 12 sample data points. Each group of students collected two environmental readings, the air temperature and either carbon monoxide, infrared irradiance, or wind speed. The same fieldtrip activity was carried out on the following day by the remaining half of the students with the same two teachers. [Week 4]
7. **Data presentation**: Following the data collection activity the students spent the majority of the remaining lessons in the ICT suite and library working on their coursework report. In the data presentation activity the students checked and corrected their data, and annotated a map of each town with their data values and comments. [Weeks 4, 5 and 6]
8. **Data analysis and conclusions**: In the analysis activity the students used Excel to draw bar charts and graphs of the datasets, and discussed these with respect to their hypothesis and methodology. [Weeks 7 and 8]

A study guide produced by one of the teachers (see process supports, below) was provided to support the students throughout the project including maps of the route, background information on the topic, fieldwork guidelines, hints on data analysis and presentation, the coursework assessment criteria, and project deadlines. Based on the background information presented by the teachers in their introduction, and explained in the study guide, the students researched the topic and developed their research question(s) regarding the existence of urban heat islands in each of the two towns. This encouraged the students to articulate their prior knowledge and assumptions, and caused them to reflect on their understanding of the causes of urban heat islands.

Completing the methodology table required the students to explain why they were collecting the different types of data and what they were anticipating their data would show. In addition to being able to access the website resources on the sensors and GPS devices, a 'how to' guide was produced for the available equipment, which illustrated how it could be operated and how the data measures could be interpreted. Having gone through these, the practice data collection session gave the students hands-on practical experience that helped them relate the theoretical properties of urban heat islands with the practical measures and interpretations they could make for themselves in the field.

The fieldtrip was an intense one-day activity that enabled the students to collect their own sensor data and record their comments and pictures of the local environmental influences at each of the sample points across the two towns. In guiding the students through the activity the teachers helped to keep the students focused on the task and encouraged them to explain their interpretation of the data they were collecting at each location. The teachers' prompts also offered opportunities for the students to clarify and revise their understanding of the factors influencing urban heat islands.

Within the data presentation activity the students checked their data and where necessary made typographical or surface-level corrections. Having multiple groups collecting the same type of data across two days enabled the comparison of values and averages that helped the students to identify errors in their data collection. The final two activities (data presentation, and data analysis and conclusions) were completed by the students individually.

Investigation tools

The ICT infrastructure in the school included four ICT suites with sufficient computers for every student in a class, a wireless network providing Internet access throughout the school, and a laptop computer for each teacher that could be connected to an interactive whiteboard in each classroom. From discussions with the teachers and observing the students' working, it was clear that the students were familiar with using web and Office applications. The students had a high level of ICT literacy and made extensive use of Microsoft Office applications and other subject-specific applications in all of their subjects. The students used the web to inform their inquiry and help specify their methodology. Word and Excel were used to complete their coursework report and to support data preparation and analysis activities.
In selecting a set of investigation tools we wanted to identify complementary tools that could be used across the different activities within an inquiry, and could be reused in a range of different types of inquiry. Therefore, rather than selecting a specialist device for data collection in the field we identified devices that could be reused across the activities and learning contexts. The specific devices used to support the data collection activity were an Asus Eee PC 701 (UMPC); a Garmin eTrex GPS Personal Navigator; a ScienceScope DataLogger ML with air temperature, carbon monoxide, wind speed and infrared irradiance sensors; and a Canon PowerShot A460 digital camera. The Eee PC has a distinct advantage over its competitors in that it uses solid-state memory for a hard drive. This enables the machine to boot up in twenty seconds and recover from stand-by within five seconds. By closing the screen on the UMPC between data collection points the students were able to complete the entire fieldtrip using only half of a fully charged battery. The Garmin eTrex GPS navigator brought a further element of authenticity to the activity as these are the preferred types of GPS device used by geographers and geoscientists. The DataLoggers and sensors were used on loan from ScienceScope and were reliable, accurate and robust. Finally, the Canon PowerShot cameras were chosen as a relatively inexpensive easy-to-use digital camera.

A web application was developed to support the data collection and analysis activities. This was intended to help guide the students through the data collection activity, collate the datasets, and provide access to the data in a web page or downloadable as either a comma-separated values (.csv) data file (for analysing the data in a spreadsheet, see Figure 21 left) or as a keyhole markup language (.kml) file (for exploring the dataset using Google Earth, see Figure 21 right). The application was built using Drupal, an open source web content management framework (http://drupal.org last accessed April 2008), which provided a set of modules (i.e. functional components) that could be configured and rapidly extended. Through a succession of screen images and functioning prototypes, with frequent feedback from the teachers, we developed the application in a two week period. The Drupal framework is written in the PHP scripting language, and uses a MySQL database to store the content and configuration data. These are standard applications that run on commonly used platforms (e.g. Mac OS, Windows and Linux).

The choice of a standard operating system running on a powerful mobile device enabled us to develop a single application that could be used locally on the UMPC or on a web server (see Figure 20, left). During data collection the students accessed the web application running on their own UMPC. On the evening of the fieldtrip all of these machines were connected to the Internet and their data was synchronised onto a web server (running the same software), and the collated datasets were immediately available for the students to access from any web browser. During the project, those students that did not have Internet access at home and who wanted to continue working on their coursework were able to borrow a UMPC. With this they could continue to use the collated dataset via the local web application on their UMPC (in an identical way to accessing a remote web server), and analyse their data and write up their coursework report using the OpenOffice applications. Having a single web application that could be used locally or remotely helped us to bridge the classroom, field and home contexts and simplified the development process.

Within the web application, a form was used at each location to prompt the students to collect their data. Figure 20 (right) shows the web form after the completion of the twelfth location in Northampton. The global navigation within the site is shown along the top of each page. The web form is further divided into three sections: the location prompt (on the left), the data entry form (on the right) and a bar chart summarising the data collected at each location (along the bottom). The data entry form asked the students to enter their GPS location, the minimum and maximum data values measured over a one minute period, and to type in their observation notes. The observations area asked the following: how is the land being used, what are the local weather conditions, how do these affect the readings, and any other comments or notes. These prompts were intended to encourage the students to relate the local land use and weather conditions to their data readings. The summary bar chart was intended to confirm the students' actions and help them to see how their dataset was building up during the fieldtrip.

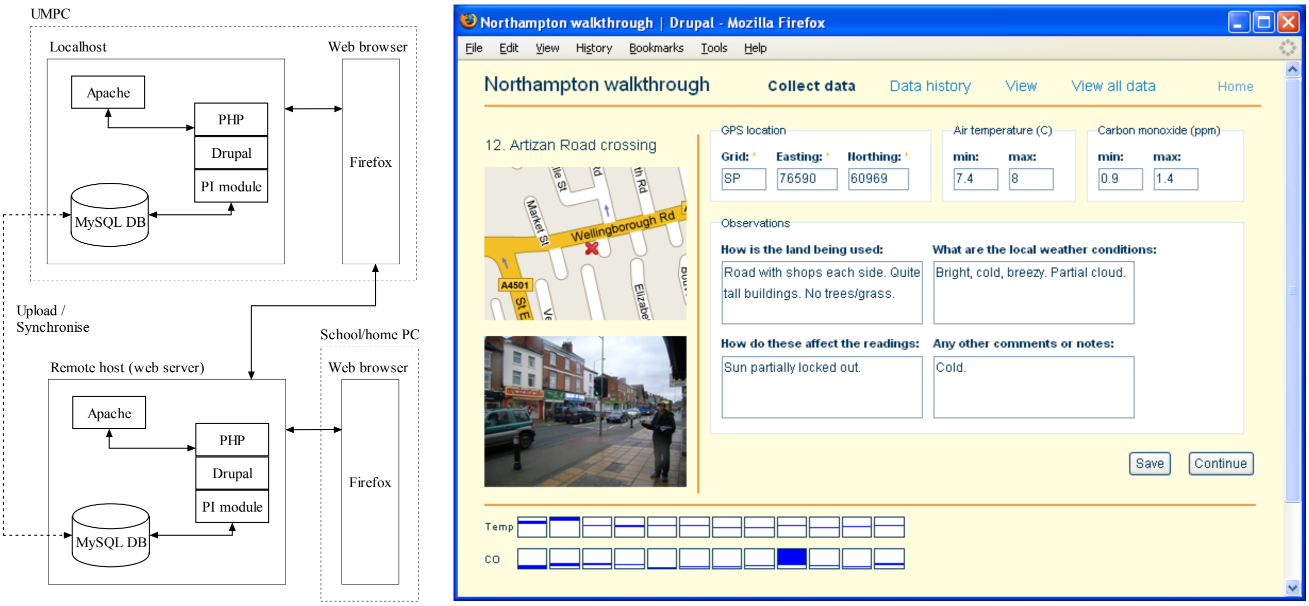

Figure 20. Web application architecture (left) and data collection inferface (right).

The web application also had a ‘data history’ page that showed the students’ dataset and enabled them to edit their entries and download the data either as a data file (.csv) or as a data map (.kml). Like the bar chart on the data entry form, the data history page confirmed the students’ progress through the task and enabled them to check and correct their data during the data collection and subsequent activities. The ‘view all data’ page was available after the data collection activity. This enabled the students to see (and download) the average values for each data type and each groups’ individual dataset from the two fieldtrip days, and a dataset from a previous fieldtrip undertaken by the researchers. The screen images shown here are of the students’ screens. An additional link was added to the ‘data history’ page for system administrator accounts that enabled us to upload the data to a pre-specified web server. By dynamically generating data files (csv) and data maps (kml) of the groups’ datasets the web application enabled the students to immediately explore their data using standard spreadsheet and Google mapping applications (see Figure 21). Having completed the data collection activity, a copy of the combined dataset from the web server was downloaded onto each of the UMPCs so that any of the students could use any of the machines to work with their data without requiring an Internet connection.

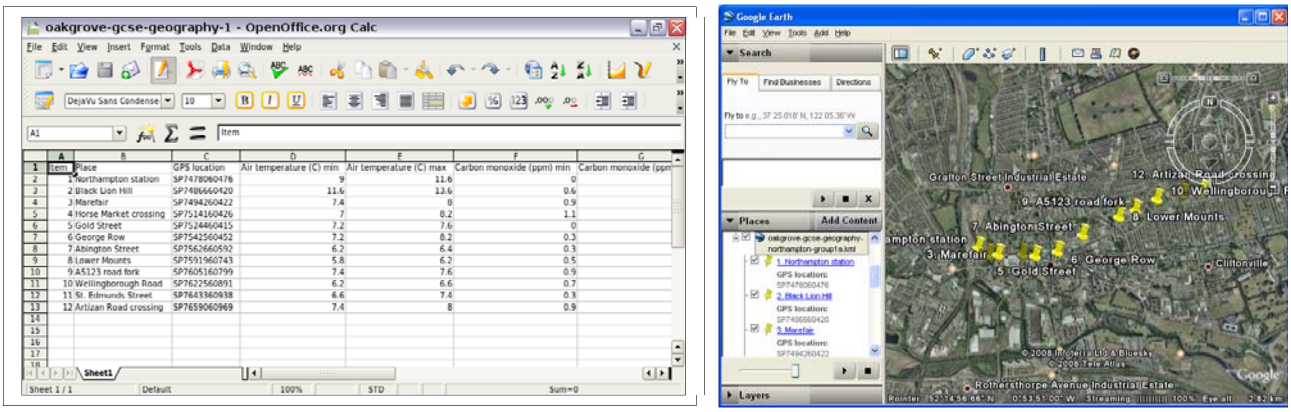

Figure 21. The data file (left - OpenOffice) and data map (right - Google Earth) generated by clicking on the download links available on the ‘Data history’ and ‘View all data’ pages.

During the fieldtrip the students were encouraged to take photographs at each location to record the land use and weather conditions. The students took many more photos than we envisaged (although they did not fill the data cards in the cameras). These images were made available to the students on USB memory sticks. The students used these to copy a selection of their photos to their personal folders on the school network, which they used as a reminder of each location and as illustrations in their report.

The students used the web application to access their data during the data presentation and analysis activities. The assessment criteria for the coursework rewarded the students’ use of ICT to present tables and charts, and to explain their interpretation of the findings. This limited the level of group discussion within each class and also the level of automation for data presentation and analysis. We could have automatically generated a statistical summary and graphs from the data, but this would have reduced the students' independent work and may have lead to a common set of interpretations by the students.

The web application developed for this project enables groups or individuals to collect data readings and comments for a set of locations. The form and number of data items can be customised for the inquiry (along with the text observation prompts) and varied for each location (if required). Where images or descriptions of the location are available these are displayed in the data collection form to help guide the user. Exporting the dataset using a set of standard file formats enables the user to work with the data using their preferred presentation and analysis tools. However, this does not limit us (or other developers) from creating further investigation tools for these activities in the future should they be required.

Process support

Along with the investigation tools used in the activities, there was a set of supporting resources used in the staging and bridging activities of the project to address the challenges of background knowledge and managing extended activities. Several of the resources were developed independently by the teachers for the students, others were developed collaboratively by the researchers and teachers for the students, and some were produced by the researchers as support materials for the teachers to help them explore the topic and the potential use of the technology.

- **List of potential online resources**: In exploring the topic a list of websites describing the causes and effects of urban heat islands were passed on to the teachers. These were reviewed and a selection of them used to inform the study guide booklet and form a starting point for the students' research. [Produced for the teachers by the researchers]
- **Study guide**: One of the teachers produced a guide for the students, which included an overview of the topic, maps of the routes taken in the fieldtrip, and guidance on the fieldwork and project write-up. [Produced for the students by one of the teachers]
- **How to guides**: A double-sided A4 page was produced for each item of equipment explaining how to operate it and (where appropriate) how to interpret the readings. [Produced for the students by the teachers and researchers]
- **Methodology table**: A double-sided A4 page containing a blank table for the students to complete was produced to help the students clarify their use of the data collection equipment and their intended interpretation of the results. A completed table was also produced and used by the researchers to help guide the 'practice data collection' activity. [Produced for the students by the teachers and researchers]
- **Sample datasets and maps**: Pilot datasets were collected in both towns using the same equipment as the students' prior to their fieldtrip to identify suitable locations, and ensure the data collection activity could be completed in the time available and that the data collected would be appropriate for the intended inquiry. [Produced for the teachers by the researchers]
- **Data spreadsheets and charts**: In addition to generating pilot datasets and maps, spreadsheets and charts of the fieldtrip data were compiled and made available for the teachers to help them guide the students' data presentation and analysis activities. [Produced for the teachers by the researchers]
- **Example analysis graphs**: One of the teachers created an example graph of some of the data and showed it to the students at the start of their data analysis activity. The teacher used the example to illustrate the process of data analysis and explained how the students could go about interpreting their data. [Produced by one of the teachers for the students]
- **Flickr website**: The photographs taken during the pilot data collection activities were put on a public flickr website during the course of the design process (http://www.flickr.com/photos/22059888@N04/ last accessed April 2008). These images were also made available to the students to ensure they had at least one photograph of each location. [Produced for the students by the researchers and teachers]

Several of the above examples were produced as collaboration artefacts that helped facilitate the co-design of the tools and activities by the teachers and researchers. The same set of process supports may not be necessary in other inquiry projects, but the role they played in encouraging and recognising the participation of the collaborators was important in this case. The study guide, how to guides, methodology table, and example graphs are process supports that directly helped the students in the inquiry process and are typical of support materials created by teachers for their students.

DISCUSSION

The following lessons learned can be drawn from the work presented here.

Motivational context

Authentic inquiry: Investigating the existence of urban heat islands in Milton Keynes and Northampton was a motivational form of inquiry because the characteristics of Milton Keynes (a new town) are very different to more established towns (such as Northampton). Therefore, the students were not repeating a previous study where the result was already known or even replicating the findings from directly comparable towns. Having contacted experts in urban geography and city planning, we were unable to find any such studies that had been completed in either town.

Guaranteed outcomes and legitimate inquiry: In preparing for the students' inquiry project the sample datasets demonstrated the suitability of the equipment and the types of measure being taken. They could also be used as a back-up dataset if the fieldtrip had to be abandoned due to unforseen problems, such as extreme weather conditions. Given that this project was to form the basis of the students' coursework having a guaranteeable outcome was necessary. However, as well as providing a 'safety-net' the additional dataset added legitimacy to the students' data as they were able to explain the similarities and differences across the datasets collected on three different days.

Sequencing activities

Hands-on practice of the experimental procedure: Having used the equipment in the school grounds to collect three sets of data during the week before the fieldtrip, the students were familiar with the equipment and their experimental procedure. As a result they were able to concentrate on collecting and interpreting their data without being overwhelmed with the operation of the equipment.

Manual versus automatic data collection: Both the Garmin GPS navigator and ScienceScope DataLogger could be set to automatically collect data traces, which would be comparable to the numerical data collected manually by the students. However, it was decided that the process of reading the data from the devices and typing it into the web form should be part of fieldwork as this would help the students attend to the data readings and how these relate to the observations they were making regarding the land use and weather conditions in each location. If the role of the students had just been to transport the recording sensors around the twelve locations in each town, it was thought that they may have been less likely to relate the data readings at each location to the local land use and weather conditions. Furthermore, giving each group member a specific device (i.e. a UMPC, GPS navigator, DataLogger, or digital camera) meant they had a clear role and responsibility.

Investigation tools

Agile tool development: As noted above, our approach to designing the inquiry activities and tools relied on the participation of the teachers involved. Through developing a series of (literally throw-away) paper prototype designs we could explore a broad range of design solutions. As the design became more focused we moved to functional prototypes and, because these were web-based applications, the teachers could easily check them and give us quick feedback via email or on the telephone. Using a content management framework enabled us to rapidly develop and revise functional prototypes, which greatly facilitated the co-development of the activities and tools. As the activities were revised the tools could be updated within a few hours and the next prototype made available for testing. Through a series of inquiry projects (such as the one presented here) undertaken as part of the PI project, it is our intention to produce a set of inquiry tools through a process of iterative and incremental development that can be used to investigate a range of topics. The underlying assumption of this approach is that through developing tools and activities across a range of inquiries we will be in an informed position to identify the characteristics and patterns from which a general inquiry toolset could emerge.

Collating and presenting shared data: The web application automatically collated the datasets to create an average set of data values across the groups on each fieldtrip. Through comparing their group data to the average data values, the groups were further supported in identifying possible mistakes in their data collection process. In a few cases the students had not entered the decimal point in a data value resulting in a significant difference between the group and average value. Another type of mistake, that this representation helped to identify, was the case where some of the students had switched the minimum and maximum values for negative data readings. Although both of these types of mistake were easy to correct, it was the average data values that highlighted their occurrence. For the GPS data any mistakes were identified once the students opened their dataset in Google Earth. As the GPS readings were recorded using Ordinance Survey grid units (OSGB36) any mistake in the easting and northing measurements resulted in the location being offset (up to 99,999 meters) either horizontally (east-west) or vertically (north-south) on the screen.

Export to common file formats: The decision to export the datasets using common file formats meant that the teachers and students were not constrained to use a particular presentation or analysis tool. In our case, it was of interest to see how the teachers and students used their chosen tools, and which forms of data representation they preferred. We can now draw on the experiences captured in this trial to inform the design of tools and activities in the future.

Process supports

Bridging representations: We found that the maps of the two towns were useful bridging representations. These first appeared in the study guide created by one of the teachers as a map of each town with markers representing the data collection points. Based on this, we added them to the interface of the web application by putting the same town maps on the home page for each part of the data collection activity. We also added zoomed map sections to illustrate each location alongside the data entry form. Maps are an obvious form of representation for location-based data, but using this common form across the methodology, data collection, presentation and analysis activities helped bridge the overall inquiry process.

Representations mixing the abstract and concrete: In presenting their work in a report the students used representations that mixed the abstract and concrete. One example of this was the annotation of their charts with photographs, explanatory text and data values; another was the annotation of the two town maps with photographs, charts, explanatory text, and data values. Both of these mixed representations explicitly related the abstract data values and graphs to the more concrete map positions, observations and photographs at each location.

FUTURE WORK

This paper presents the first in a series of trials to be carried out as part of the PI project. During the eight weeks of the project the Geography lessons were recorded (including the two fieldtrips), capturing the work of four groups of students. This has produced over fifty hours of video data which will be reviewed and analysed over the subsequent months. Copies of the students' work will also be available for analysis. A Technology Awareness questionnaire was completed by the observed students before the project began and will be completed again after they finish their coursework. The teachers and the two student groups were interviewed before they began the project and will be interviewed again when it is completed. The evaluation of the inquiry project and the process that produced it will be the focus of our ongoing work.

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Appropriation of Mobile Phones for Learning

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ABSTRACT

This paper provides a definitional base for a key concept in mobile learning, that of appropriation. We define appropriation as exploration, accommodation, assimilation and change for and in context-governed meaning-making with users/learners negotiating and evolving practices and meanings in their interaction with other users/learners, technologies and information. It explores the notion theoretically and conceptually across a typology, a number of spheres, and delineates stages of its development; we give brief examples of some of these concepts and discuss their importance in and across informal and formal learning with mobile devices.

Author Keywords

Mobile learning, (definition, types, spheres and stages of) appropriation, use genres, user agency, identity. Social, individual and cultural aspects of mobile learning.

INTRODUCTION AND DEFINITIONAL BASES

As our title suggests, this paper looks in some detail at one specific aspect of the use of mobile technologies, appropriation, which we consider to be central to our ability to understand fully their potential, particularly in relation to the interface between formal and informal learning (see also Cook, Pachler and Bradley, 2008).

We seek conceptual clarity around the notion of appropriation in the belief that any academic field needs a sound ontological and definitional basis and that, in order for the discipline of mobile learning to reach maturity, clarity about key concepts and their meaning are a pre-requisite to scholarly debate. Brodie (in Fensel, 2004, p. vi) defines ontology as "a community-mediated and accepted description of the kinds of entities that are in a domain of discourse and how they are related. They provide meaning, organization, taxonomy, agreement, common understanding, vocabulary, and a connection to the 'real world'." Appropriation, in our view, whilst being a central concept in understanding the use of mobile devices in learning, remains a largely ill-defined notion that is mostly used in a manner that lacks reflexivity.

We argue that one of the defining differences between technology-enhanced learning to date, including e-learning, and the use of mobile devices, relates to the fact that learners themselves mostly own the mobile devices. This, in our view, has a number of significant implications, in particular in terms of motivational and affective factors as well as identity building, which are known to play a significant role in the learning process (see also Pachler, Bachmair, Cook and Kress, forthcoming; Stald, 2008).

Appropriation, broadly speaking, we posit, is the process of users/learners making technological tools their own and harnessing their functionalities for their own purposes, be they those intended by the designers and manufacturers or be they different ones. We propose a definition of appropriation as exploration, accommodation, assimilation and change for and in context-governed meaning-making, with users/learners negotiating and evolving practices and meanings in their interaction with other users/learners, technologies and information. Appropriation is the process of making the technological tools at one's disposal one's own, by making them fit personal, interpersonal and social requirements, rather than using them necessarily only in accordance with designed-in functionalities and/or accessorising them. We view appropriation as being characterised by user agency, as actions on tools and devices with users/learners actively making choices, e.g. by engaging in processes of selection, adaptation and implementation.

The term appropriation is in use in and across a number of spheres. In this paper, building on the definition set out above, we will explore the notion of appropriation theoretically and conceptually across socio-cultural and technological spheres, delineate stages of its development as well as discuss its importance in and across informal and formal learning with mobile devices.

TYPOLOGY OF APPROPRIATION

We are proposing the typology of appropriation for users/learners in Figure 1. We view this typology as a systematic classification of mobile learning appropriation 'types' that have characteristics in common. We posit here that there are three types: socio-cultural, interpersonal and personal. Each of the types shown in Figure 1 has various characteristics, which implies some purpose or intention of a mobile appropriation activity rather than the function of some task. However, we want to stress here that there are invariably purposes/intentions that cannot always be neatly associated with specific branches and that, according to one's perspective and/or particular situations and contexts, different attributions would be possible. For example, 'media capture' could easily be featured as a characteristic not only under 'personal' type but also under other types. However, in an attempt to avoid duplication and complexity, we have listed the various characteristics where we thought there was 'best fit'. Note that some of these types will reappear in the context of our spheres discussed below.

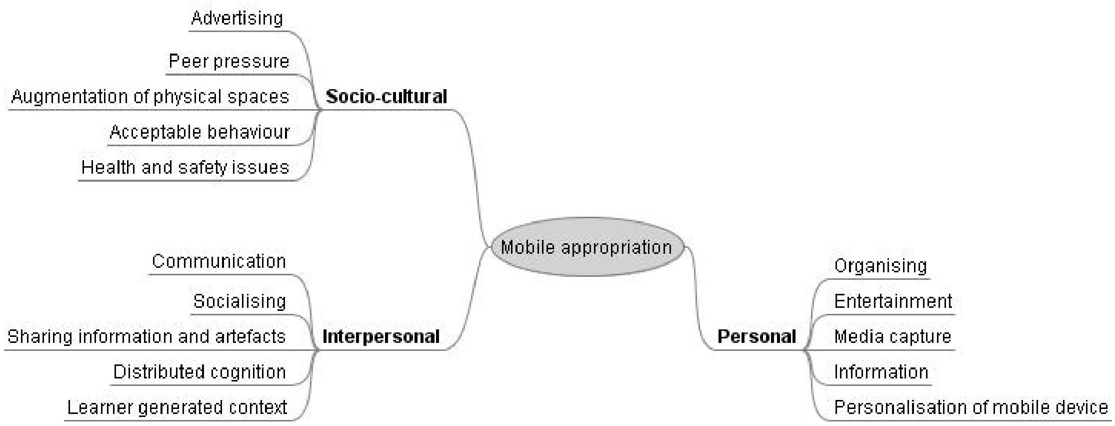

Figure 1: Typology of appropriation

With the personal type, the bottom right of Figure 1, many users/learners now appropriate mobile devices to perform a number of day-to-day organising functions to support their needs, such as using the calendar, setting reminders and alarms and keeping contact details. Mobiles can increasingly be used for entertainment, for example, playing music, games, listening to the radio or watching TV. Many people now use their mobile as their primary source for capturing media, in the form of photographs, videos and voice recordings. It is extremely common now at any event or occurrence to see people capturing it using their mobile phone. And the mobile is becoming a tool for seeking and gathering information, whether it is accessing maps or the internet, calling someone for information or using learning materials. The number of characteristics appropriated clearly increase with the sophistication of the device and the features it has. One's mobile phone is an inherently personal device (people rarely share mobiles), and this can be enhanced by personalisation or accessorising a phone to put one's own personal stamp on it. This is mainly achieved by adding skins or covers and accessories, and by personalising ring tones, operating systems and menus as well as by adding wallpaper.

In the bottom left of Figure 1 is the interpersonal type. Appropriation of mobile devices for some of these characteristics is to be expected as they have been designed primarily as communication tools. Communication for us is more narrowly transactional (e.g. person-to-person messaging), whereas socialising relates to identity building (as discussed above). We communicate in order to find out train times or carry out a work task but we socialise to build friendships and other relationships. Personal networks at all levels can be built and sustained (family, friends, work, college) through keeping in touch by calling, SMS, email, arranging meetings and so on. However, interpersonal activities can be extended by sharing digital media with others, such as photographs, ring tones (via Bluetooth or MMS for example). An interesting example is Jacucci, Oulasvirta and Salvaara (2007), who discuss the contribution of mobile phones in the creation of technology-mediated memories in constructing shared experiences amongst spectators of a rally. This user genre they call 'active spectatorship'. Distributed cognition is related to the latter, and refers to a branch of cognitive science which puts forward the idea that knowledge and cognition are not confined to the individual but are, instead, distributed over networks. In a context of ubiquitous connectivity, inter alia through mobile devices, we would draw on distributed information in our actions on the world as well as processes of knowledge-building and meaning-making of the world. The notions of acting on the world through the use of mobile devices and of distributed cognition leads onto the characteristic of learner-generated context, by which we understand contexts 'created by people interacting together with a common, self-defined or negotiated learning goal'. The key aspect of learner generated contexts is that they are generated through the enterprise of those who would previously have been consumers in a context created for them" (Learner Generated Context Wiki, 2008). As Cook (2007) points out, a 'mobile learner-generated context' can be seen as interpersonal activity "conducted by learners who may be communicating or individually reflecting 'on the move' and who, in the course of a dialogue with another person or interaction with multimedia resources, raise questions that create a context; when an answer to this context-based question is generated this can give rise to knowledge".

The top-left of Figure 1 shows socio-cultural characteristics, which impact on appropriation in a number of ways. Advertising and peer pressure influence many people's choice in purchasing particular mobile devices, for example, wanting to have the latest fashion accessory, the latest features, the latest models, and can also influence what they appropriate their devices for. One person's appropriation can influence another's. Augmentation of physical spaces through pervasive wi-fi and 'smart' buildings is another socio-cultural characteristic of appropriation. At the ALT-C 2007 Symposium *Tensions Between Personal Space and Social Space in Mobile Learning* (Kukulska-Hulme et al., 2007), Cook paraphrased Bruce Sterling (2007) in order to take the ideas surrounding community space one step further and described social space as having potential for hyperlocal m-learning: "This is hyper as in linked and local as in location. It's a new kind of city in which you're never out of touch with other friends and learners, and never out of learning choice". Here mobile phones are used, for example, to ascertain which of one's contacts are within physical proximity and to enable virtual communities to form physically. Another example of hyperlocal mobile learning could involve the use of Quick Response (QR) Code, which is a 2D matrix code designed to be decoded at high speeds via mobile phones. QR Codes (a trademark by Denso Wave, Inc.) store addresses, and URLs may appear on buildings, on signs, below paintings in exhibitions, or on just about any object that a user/learner might need information about. A user with a camera phone equipped with the free reader software can scan the QR Code by taking a picture of it and is then linked directly to URLs, small e-books, images or videos etc. This act of linking from physical world objects to the digital world provides the opportunity, for example, to find reviews of an exhibit that is the focus of a learning task. A user/learner can also generate and print their own QR Codes for others to scan and use by visiting one of several free QR Code generating sites. Acceptable behaviour refers to social norms surrounding the use of mobile phones. For example it is considered impolite in the UK to hold extended noisy personal conversations or play music through the speakers on crowded public transport; that does not mean to say this practice is not uncommon. Another example is the removal of mobile phones from school children when they enter the school, even though these devices could be used for learning (see Pachler et al., forthcoming, for a discussion). Health and safety issues can have a negative impact on appropriation, for example fears of radiation might limit use, or use in public spaces might be restricted because of concerns of mugging and theft. However, some people feel safer with their mobile phone, as they can make contact with someone if they need help. One student in a study we recently conducted (see e.g. Cook, Pachler and Bradley, 2008), for example, noted that she used the mobile phone to talk to a friend when walking home alone at night so she wouldn't be afraid. The mobile phone, in this example, assumes a very specific role in relation to (perceived) personal safety.

SPHERES OF APPROPRIATION

We have already noted that the notion of appropriation is in use across different spheres and have provided some examples. In the following, we examine the socio-cultural and technological levels of appropriation conceptually and theoretically, leaving aside, for example, its use in legal contexts (i.e. if you 'appropriate' a phone in a legal context you steal it). Thus it is important to note that the typology in Figure 1 enumerates key categories, but when it comes to a discussion of spheres some types subsume other types. Thus, within the socio-cultural sphere, we distinguish between personal, interpersonal and systemic levels. Key questions for us include: what are the key characteristics of appropriation in and across these spheres? To what extent is the effective use of technology premised on the ability of the individual and/or their life world as well as their worlds of work to envision possible uses? Within what socio-cultural traditions, values and codes of behaviour is appropriation situated and how is it constrained and/or enabled? Through what stages, if any, does appropriation develop? And, what are the implications for learning with mobile devices?

Referring mostly to the systemic level, Hård and Jamison (1998) contend that cultural tradition plays a considerable part in conceptions of technology and technological power. Misa (2007), and Hård and Misa (2008), have recently elaborated on this by looking at different cultural perspectives and how "differences in technological choices between societies can often be related to locally situated processes of social and cultural 'appropriation' " (Misa, 2007). This is a view shared by Stald (2008, p. 149) who argues that

> several sets of conditions affect the adaptation rate and the common as well as unexpected uses in different national and cultural contexts: they include cultural factors (traditions, norms, trends), social aspects (legislation/ regulation, needs, norms), and practical constraints (access, economy, infrastructure, work/study/home distance).

Leaning (2005) has extended these cultural perspectives of appropriation to propose a sociological model for understanding the social appropriation of information and communications technology (ICT). He argues that "the relationship between a media form and the society in which it is deployed is of key importance in understanding how media is used." By drawing on the work of Williams (1974) and others, Leaning gives an account of "the way in which the power of ICT to affect society has been understood" and notes that "positions within this debate are deeply tied to Western cultural beliefs and values". In other words, he deems application to be much more closely linked to "the social organisation of the society in which technology is deployed than any essential qualities the technology itself is understood to possess." He proposes a model of technology in which "ICT is regarded as 'modal' in operation, that is, it may operate differently in different situations." Leaning argues that media are a socially contingent means of communicating information and, following Kress and van Leeuwen (2001), that the Internet itself is a mode of communication, or that it is to be seen as a modality of cultural transmission and, as we would argue, production. For

Leaning, ICTs should be conceptualised as “a modal form of media and their use and appropriation may vary according to the environment in which they are used. Therefore, to examine ICTs, attention should be focused upon the interdependence of social systems, media technology and form of action studied.” This perspective gives us a useful conceptual starting point for looking at appropriation as being a socially contingent form of cultural transmission and production, where technology is not viewed as some external force affecting society, but as a phenomenon constructed, appropriated and understood by society. We take the notion of ‘interdependence of social systems’ to mean the relationships between different social groupings to which we belong (e.g. religious, ethnic, professional etc.). We do not want to confine our perspective on ‘cultural transmission’, but see the process of ‘cultural production’ with new technologies, and in particular mobile devices, as being key. And, we view mobile technologies as cultural resources for meaning-making, i.e. the ‘production’ of culture with a diverse range of semiotic means, and, thereby fundamentally bound up in socio-cultural practices rather than as independent from them. The contingency on social settings underpins our differentiation into personal, interpersonal and systemic levels of the cultural sphere as different patterns of use can be observed and distinguished in all of them. Bachmair (2007), for example, powerfully demonstrates media preferences according to social milieu.

In addition to the existence of these spheres, we need to understand the frames that govern the actions of individuals as they create meaning in varying social and cultural contexts. If mobile devices can be understood as being modal and socially contingent, i.e. something that may be used in a particular way in one context but in a different way in another, we still need an account of learner agency in relation to the act of appropriation in different settings.

In her book *Internet society*, Bakardjieva (2005) looks at the everyday use of the Internet. She presents a framework which combines concepts from several schools of thought (social constructivism, critical theory, cultural studies and phenomenological sociology) in an attempt to overcome some of the limitations of these perspectives. For example, Bijker (1995) in the book *Of bicycles, bakelites, and bulbs*, featured many interesting tales of bikers, told from a perspective of the social construction of technology, but does not explain why first time bike-riders were prepared to take the risk of jumping on bikes that would inevitably wobble a lot and from which the early user was likely to fall off; that is, the issue of agency is left unanswered. We need more narratives or cases as we call them (Cook, Pachler and Bradley, 2008), if we are to truly understand how users/learners select, appropriate and implement technologies and tools to suit their own social learning context. Bakardjieva (2005, p. 34) characterises her approach as “technology-in-use-in-social-situations”, or technology extended to include the acts of use in social situations. This is where a user enacts or invents genres of use, i.e. they mobilise available cultural tools to respond to a social situation.

Bakardjieva (2005) and Dourish (2004) both point out that people often find ways of using technology that are unexpected or unanticipated. For example, the adoption patterns of SMS messaging has taken on a form of use that was not anticipated by the designers of SMS, which in the early 1980s was only envisaged as being used for voice mail alerts or for telemetry (Wikipedia 2008). Even when the general patterns of technology usage do conform to expectations, “the meaning of the technology for those who use it depends on how generic features are particularised, how conventions emerge, and so on” (Dourish, 2004). Thus, specifying the functional design of a mobile phone in the abstract is one thing; understanding how specific groups of people will make use of particular functions is quite another. Users, not designers, determine the meaning of the technologies that they use, through the ways in which they incorporate them into practice. Technologies like computers and mobile phones are already steeped in the achievements of earlier users; however, by incorporating them to our own situation, we actively select, ‘appropriate’ and implement them to the contexts of our own circumstances. For example, consider the computer interface versus what we do with the computer in our everyday lives. Computers and software for it, by-and-large, have originally been developed for work-related activities and as productivity devices; however over time, in response to developing genres of use, they have become appropriated for entertainment, education, socializing, etc. By engaging in appropriation of technology, users/learners can give technology a new, possibly peculiar, spin that others may adopt later: “users are active participants in the emergence of ways of working” (Dourish 2004). Appropriation, therefore, is an action on tools (e.g. making blogging work to suit our own needs), whereby learners negotiate and evolve systems of practice and meaning in the course of their interaction with other users (e.g. learners, tutors, etc.), technologies and information structures. The way in which the ‘meaningfulness’ of a technological artefact arises is, therefore, related to its use within ‘systems’ of practice over a period of time.

Jones and Issroff (2007) have reviewed recent work on technology appropriation, which they define in terms of user agency as follows: “the process by which technology or particular technological artefacts are adopted and shaped in use”. Two different approaches to mobile phone appropriation are discussed; that of Carroll et al. (2002) and that of Waycott (2004, 2005). As Jones and Issroff rightly point out, neither of these approaches have a specific focus on learning. Jones and Issroff (2007) then go on to draw on case-study data “in order to illustrate and discuss the extent to which these two approaches are helpful in informing our understanding of the motivating features of using mobile devices for informal learning” (p. 247). Part of the purpose of our discussion is to reflect on some primary data from ‘technologies-in-use-in-learning-situations’ from the perspective of appropriation.

Before we do so, however, we inter alia want to first report on findings by Stald (2008), who carried out a series of empirical studies of 15-24 year-old Danes and their mobile phone use, as in our view they illuminate the personal and interpersonal levels of the socio-cultural sphere. Stald’s work clearly demonstrates the importance of appropriation of mobile phones in young people's lives, in particular in relation to (learning about) identity, although she does not use the term appropriation as such. Stald rightly notes the affordances of mobile phones – again not a term she actually uses – for establishing social norms and rules at a personal and interpersonal level. According to her, the identity of young people is fluid and that they are "constantly negotiating who they are, how they are that identity, and with whom they are that identity" (p. 143).

> (The) mobile itself provides signals about the user's identity or at least their self-presentation. The use of language, spelling, their actual way of interacting in dialogues, and the use of additional communicative elements and services also reveal things about the user's 'personal settings'. (p. 161)

The mobile phone, according to Stald, is "a learning tool for dealing with living conditions in modern society" (p. 144); "we use the mobile phone to carry our social and personal life with us as we move" (p. 145) … and "it supports the testing of cultural, social, and individual codes and makes ongoing, mutual reciprocity possible" (p. 146); "we are constantly negotiating our mutual understanding of the situations in which we find ourselves" (p. 145). The ability to use mobile phones effectively in accordance with perceived needs can, therefore, be seen to be increasingly important, particularly for young people as communication through mobile phones is also about the maintenance of relationships and "express(es) codes of dominance, levels of interconnectedness, types of relationships, and so on. It can serve as an important means of mutual social confirmation and trust in each other" (p. 155).

Stald's work is also interesting in so far as she brings the socio-cultural and technological spheres into a fruitful relationship with each other by introducing the metaphor of a 'shell' for the mobile phone, which can be appropriated by users by way of choice of telephone number, skinning and the personalisation of ringtones and backgrounds, a device that encapsulates and protects, "which encloses their social life and networks, emotional experiences, personal information and so forth" (pp. 150). The technical sphere can usefully be conceived from the starting point of the designed functionality of the device as intended by the manufacturers that produce the device. Thus the ability to hold music on our mobile phone is a technical provision. However, such an affordance leads to the notion of the owner of the phone seeing the device as part of their personal life-world and they start to use the device to build their own identity (we return to this issue below). In this way the socio-cultural and the technical spheres are clearly interrelated.

STAGES OF APPROPRIATION

In the following, we will discuss possible stages of appropriation within the broader socio-cultural sphere. We will do so in the main with reference to the personal and interpersonal levels of our spheres here as, in our view, a discussion of organisational/systemic levels would go beyond the scope of this paper.

In an earlier study, Carroll et al. (2002) also looked at the role that mobile technologies play in the lives of young people, albeit not in relation to identity. Instead, their focus was directly on appropriation, which they define as "the way in which technology or technological artefacts are adopted, shaped and then used by young people". Clearly, there is overlap here with our definition of appropriation given in the introduction, although what is missing, we think, is the key notion of the interaction in emerging practice.

Carroll et al.'s (2002) work is, however, of further interest because it attempts to delineate a model for technology appropriation with direct reference to mobile phones. In doing so, the authors draw on data collected from various studies in order to elaborate on a conceptual model that had formed their starting point, with a view to determining the factors involved in appropriation across various stages. It is also worth noting that, unlike Stald, they approach their work from a design perspective and are interested in appropriation in terms of the transformations of 'technology-in-use' compared with that envisaged by its designers, what they call 'technology-as-designed' (p. 1778). In particular, they are interested in the factors that result in the integration of technology into the users' everyday lives as well as in any barriers. Their findings suggest that successful appropriation in the socio-cultural sphere is contingent upon critical mass in a social group (p. 1780).

In essence, Carroll et al.'s appropriation model (p. 1781) suggests that in the first instance, at Stage 1, the question is whether there exists a sufficiently strong 'pull' of the so-called 'attractors' designed into the technology such as usability, convenience, fashion and cost to make potential users want to experiment with the technology. At the second stage, certain appropriation criteria come into play, such as leisure use, social and information management or lifestyle organiser, which determine whether the initial interest in the technology leads to appropriation or disappropriation. In other words, does the technology add any value? The final, third stage relates to reinforcement through social use in groups, with power and identity being listed as higher order reinforcers, and fragmentation being thought to lead to disappropriation. Our proposal is to conceive of these three stages in terms of exploration (Stage 1), adaptation, accommodation and assimilation (Stage 2) and change (Stage 3). 'Exploration' is characterised by the process of finding out about the functionality and potential of the devices; accommodation and assimilation are the incorporation of the devices into the user's life worlds and (social) practices whereby technology is used in accordance with existing practice or where existing practice is modified in line with the functionality and characteristics of the technology or in line with established socio-cultural norms; and 'change' we view as modifications to personal and social practices on the basis of the affordances of the technology as well as the pushing back of the boundaries of existing socio-cultural norms in relation to the use of the technology. We agree with the assertion in the literature that stages of such a model should be viewed as being non-linear but instead as cyclical and recursive (see e.g. Carroll et al. 2002 and Jones and Issroff 2008). We also want to stress the agency by the user/learner underpinning the process of appropriation, i.e. of making technology their own for purposes of identity formation, social interaction, meaning-making and entertainment.

> Once a technology is appropriated and integrated into the lives of young people, its use is reproduced or reinforced through reference to these higher-order drivers. As long as the technology fits with the needs and lives of young people, its use will be reinforced and stabilised; it may become a mundane part of their everyday lives. At the same time, it will shape their needs and lives, offering new ways of living and interacting in the world. (Carroll et al 2002, p. 1783)

In short, young people adopt a lifestyle rather than a technology perspective (p. 1784).

In their discussion of Carroll et al.'s work, Jones and Issroff (2007) point out that these three stages do not deal with different learning contexts. They also discuss Waycott's (2005) study, which looked at the appropriation of PDAs in the workplace and as a learning tool using a framework that draws heavily on activity theory analysis. Waycott highlights both technology appropriation and technology mediation, with the latter being the adoption of the technology. The mediation component thus describes a process whereby the PDAs change the activities that they support, in our terminology, the users create new use genres to meet a specific social need. Waycott examines some of the past experiences and personal circumstances (i.e. biographical details like time and inclination) with respect to the PDAs.

Because of the gap of 3-4 years between the two studies, comparisons are difficult as the devices available were very different, as were the contexts of use. Nevertheless, as Jones and Issroff (2007) point out, in both models of appropriation, being part of a community and supporting others was seen as being important. Indeed, in Waycott's study, community knowledge also played a part in participants' choice of not using PDAs anymore. What is striking, however, is that neither study centrally tackles the issue of identity or relates the stages more overtly to a learning context in which mobile devices are appropriated, which in our own study forms an important feature (see Cook, Pachler and Bradley, 2008).

EXAMPLES OF APPROPRIATION IN SOCIO-CULTURAL SPHERE AND AT STAGE 2

This section uses brief and highly selective examples from a recent study (Cook and Bradley, 2007; Cook, Pachler and Bradley, 2008) in which students visits an 'event' as part of an assignment for an MA module called 'Events and Live Media Industries'. The students have to work in groups to prepare for a multimedia presentation, and each student was loaned a Nokia N91 phone to help them with the task. Each phone came pre-loaded with a simple mobile learning object called 'events checklist'. Thus the assignment task required the students not only to gather data in the form of video or audio clips and photos, but also to answer certain questions (i.e. fill knowledge gaps) that were posed by the events checklist.

Students were interviewed in groups (Cook and Bradley, 2007). A month later in-depth interviews were held with three of the students in this study (Cook, Pachler and Bradley, 2008). The three students were all female, international (none of them were from the UK) and in their early twenties. We have given these three students pseudonyms in the text below in order to maintain anonymity. Due to space limitations, below we only present example for Elli. However, both sets of interviews gathered a number of examples of how learners have appropriated their phones for both learning and non-learning tasks.

In the socio-cultural sphere, Elli noted a difference in cultural attitudes towards mobile phones and new technologies generally between her native country of Greece and England. "I mean there are people that are technology freaks back home, but most of us, we would never stay in, we would always go out. So if you think that most of your day you will spend it outside you don't have a big relationship with technology you just have a mobile for "where are you?" "I'm on the third coffee table on your left, come and find me." … But here in England I was shocked how important technology was." Elli was one of the only students to mention her mobile in relation to health and safety issues. "In an emergency, I feel quite safe. For example if I walk at night, my friend who's got free minutes will call me and she says "where are you?" And she walks with me." However she did say that her mother tells her that by using her mobile a lot "my brain is going to be fried from it".

At the personal level of the socio-cultural sphere, Elli talked about appropriating her mobile phone for organising daily and routine tasks. She said that initially she used her phone for calling people and sending messages "But now I use a lot, the calendar, the agenda, like reminders. I'm awful with reminders. I might have in my phone like 400 reminders a day. "Beep beep beep – 2 things," because I keep forgetting, like, deadlines." Her phone has become a 'personal organiser' for her, but she is also conscious that she should not become dependant on her mobile, for example for storing phone numbers, because she doesn't want it to take over her life. She also had a bad experience when all her phone numbers were lost when a previous mobile broke and became unusable. Elli's use of her mobile phone as personal organiser we consider to fall within Stage 2 of appropriation, i.e. adaptation, accommodation and assimilation.

All three students said that having a mobile device that can play music was important to them. Elli admitted to appropriating the loaned phone for personal use, "I actually took the Nokia on a vacation. I went for 4 days and we took 120 pictures because my digital camera was broken". These examples are also characteristic of Stage 2 of appropriation.

Elli said about learning content on mobiles, “It’s nice. Always depending on what the learning tasks are. If it’s something like the one we did, where went to the event, it’s packed with people, you are already holding all the brochures and all the junk they give you so you have the mobile phone. You have the guidelines, you don’t need to bring more paperwork with you. You don’t need books you have it there, it’s just a click away. Yeah, it was very useful.” Elli was the only one to mention personalisation, “You can change their colours or you can have it in different designs so I bought a purple case so it was very much into me. So I really liked it, you know, very fashionable, very me. I liked it.” She made her phone match her personality and personal style.

SYNTHESIS, CONCLUSION AND OUTLOOK

In summary, this paper explores appropriation from various theoretical and conceptual perspectives. We defined appropriation as exploration, accommodation, assimilation and change for and in context-governed meaning-making with users/learners negotiating and evolving practices and meanings in their interaction with other users/learners, technologies and information. Furthermore our view is that there are three types of mobile appropriation: socio-cultural, interpersonal and personal. Appropriation is also in use across different spheres. We examine the socio-cultural and technological dimensions of appropriation and note that within the socio-cultural sphere, we can distinguish between personal, interpersonal and systemic levels. A useful conceptual starting point for looking at appropriation is one were we view it as being a socially contingent form of cultural transmission and production, where technology is not viewed as some external force affecting society, but as a phenomenon constructed, appropriated and understood by society. Indeed, mobile technologies are a cultural resource for meaning-making, i.e. the ‘production’ of culture with a diverse range of semiotic means, and, thereby fundamentally bound up in socio-cultural practices rather than as independent from them. Specifically, we take the view that users/learners enact or invent ‘genres of use’, i.e. they ‘mobilise’ available cultural tools to respond to a social situation. This can result in people finding ways of using technology that are unexpected or unanticipated; this is technologies-in-use-in-learning-situations. Mobile phones provide affordances for establishing social norms and rules at a personal and interpersonal level; for example, the identity of young people is fluid, they are constantly negotiating ‘who they are, how they are that identity, and with whom they are that identity’.

By examining learning-specific examples, i.e. cases or genres of use, we are able to find support for our conceptual assertion that mobile devices can be viewed as cultural resources for meaning-making in social contexts. The learner in one example examined in this paper is actively engaged in forming their identity. That is to say, the mobile phone is a cultural resource in that it comes with culturally formed ways of usage, the way in which the learner has in the past internalised this usage is also achieved in response to cultural factors. When the learner in our example starts to appropriate the device in a new (to them) practice and when they then go on to share this practice with other learners, this interaction in turn evolves the learner’s practice. In this sense, mobile devices are a resource for identity formation and practice evolution. This process may be itself distributed over several different contexts and over a period of time; it is cyclical and not linear. Using another learning-specific example we illustrated how learners incorporated texts from their tutor (study tips) into their practice, i.e. learners would accommodate these texts but as they became used to them they were able to use the approach readily for meaning-making; they could be said to assimilate the affordance of this technical functionality into their socio-technical sphere.

Thus the notion of agency by the user/learner underpins our notion of the process of appropriation, i.e. of making technology their own for purposes of identity formation, social interaction, meaning-making and entertainment. We are the first to admit that various issues need further investigation. The influence of affective factors in this process needs further exploration. For example, can certain affective dispositions inhibit the types of appropriation we have described in this paper? What is the relationship between identity and affective dispositions? However, we claim that the exploration of the key notion of appropriation in mobile learning undertaken here has taken us an important step further in elaborating what it is to achieve learning from context to context. By traversing the stages and spheres we have enumerated, it should be possible to see where our learners are and where they need to go in terms of their chosen learning contexts. And it is this particular aspect of our work on appropriation that we consider to be an important aspect of future research: in what ways are users/learners making technology their own in formal (as well informal) learning situations. Also, how do the stages of appropriation we delineated above play out in this context and, how can they be supported and underpinned pedagogically in order to support emerging learning processes.

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A Situation Based Metadata for Describing Pervasive Learning Objects

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ABSTRACT

Pervasive learning systems must define new mechanisms to deliver the right resource, at the right time, at the right place to the right learner. Learning objects are thus one of the most important features of these systems. Metadata and learning object structure are important in order to represent, manipulate, manage and deliver them to users according their knowledge and context. In this paper, we present an enhanced pervasive learning object model with the principal notion situation and also its quality model which allows us describing the context, situation of use of each learning object. Moreover, by using this model, our system can apply both static and reactive adaptation strategy.

Author Keywords

Pervasive learning, learning object model, context, situation, adaptive learning

1. INTRODUCTION

We are in an age of personal and technical mobility where users can carry mobile devices such as PDAs, phones, Ipod, etc everywhere. This fact opens a new era for learning based on mobility by which a learner can achieve his/her learning objectives in an anywhere and anytime fashion. We call this type of learning as mobile or pervasive learning. Many problems of this learning are investigated in research like: linking people in real and virtual words, providing knowledge on demand, supporting learning every time, everywhere and using every device, how to collect and represent user's physical context, etc. (Sharples et al 2008).

Learning objects are considered as the main component in all learning systems. A learning object is generally defined as "any digital resource that can be used to support learning" (Wiley 2002). This comprehension is not fully satisfied because according to it, the learning support platform, calendar, event, and people can be classified like learning objects. We share with Allier (1997) about learning object definition which is practical and implementable: "*A learning object is defined as the smallest independent structural experience that contains an objective, a learning activity and an assessment*." Objective here is learning intentions, learning activities help learner reach that intention and it can be verified by the assessment.

The major problem related to a learning object is its representation and management. This task can be done using metadata to identify, search and classify learning objects. Standards like Dublin Core and Learning Object Metadata (IEEE 2002) created by Dublin Core Metadata Initiative, IEEE Learning Technology Standards Committee (LTSC) and the IMS Global Learning Consortium, Inc. (IMS 2003) are most often used. The drawback of these works is that we can not embed in learning object its context and best situation of use which is an important point allowing discovering contextually and recommending appropriate learning object according to user's situation.

This paper describes our proposition of a learning object model in order to create, manage and deploy learning objects in pervasive learning systems. Moreover, we can combine formal and informal learning depending on the design of learning object.

This paper starts with an overview of the proposed pervasive learning system by presenting the main developed notions and the general architecture. In section 3, we focus on the pervasive learning object model which is the main contribution of this paper. We show how this model contributes to achieve a better contextual adaptation and reusability of learning objects. The article ends by giving with a short summary and some future works.

2. BACKGROUND

In this section, we present our pervasive learning system which is the extension of older adaptive learning systems. Through an adaptive learning system, a learner can receive the best learning object according to his/her knowledge and profile (preferences). In this system, three models collaborate (Bouzeghoub et al 2006): user model, resource model and domain model. The domain model is used for indexing both of user and resource model. In the context of pervasive learning system, learning resources must in addition be adapted to user's situation. A learning resource must be delivered or recommended to the user at the best moment, in the best location and by the best device. In order to do this, we must take into consideration user's context i.e. all available information around him. This section presents our proposal context model with its different dimensions as well as the situation model and show how these model collaborate throw a general architecture.

2.1 Context

The context notion is the most important element in the context awareness systems. In the literature, we can find many works trying to define this notion (Schilit et al 1994, Dey 2000). The context has a long history but there is not any standard definition about it. The general comprehension about context is the location and environment around a person or an object. The other point of view is oriented to one user: his/her location, plan, data, other users or object around of him/her.

The definition which is the most accepted in the ubiquitous computing domain is of Dey (2000). "*Context is 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 the application themselves*". This definition is not only focused on users but also to other entities like locations, devices also on other entities like locations, device, etc. We share this definition and use it to propose a context model and define other notions. Indeed, in learning domain, the context notion must take into consideration moreover learning aspects like learning activities and learning support platforms. The context plays a role for: (i) Describing and reusing learning objects in different contexts. (ii) Collecting contextual traces of usage. (iii) Offering a better adaptation of the learning process and learning resources. The context model we propose consider these objectives. It includes three principal notions: context dimensions, situation and event.

2.2 Context dimensions

In order to deliver adaptive resources to user, contextual information are collected and gathered in dimensions. We have developed six dimensions: User, Activity, Location, Time, Environment and Device which are related by semantic relationships (ex: use, in ….).

User: This dimension organizes users' information according to user model. Our user model has two parts: (i) user knowledge and (ii) user preferences. This model is inspired by an overlay model which uses the domain ontology to indicate the level of knowledge of the user on each concept.

Activity: User activities (at low level or at high level) are defined and organized in the activity dimension. "learning, revise, read, discus, collaborates, etc." are user learning activities at high level and "click, move…" are common activities at low level.

Location, Time, Environment and Device dimensions are described in (Bouzeghoub et al 2007)

2.3 Situation and Event

In order to make easier the usage of context, we present the situation notion which describes contextual information during an interval of time. Our definition of situation is that *a situation is a state of the universe which is valid during an interval of time*. Applying the notion of context dimension, we refined it as: a situation corresponds to *a set of semantic relations* (in one context dimension or between two context dimensions) which are *valid* at the moment and *stable* during an interval of time. Thus, semantic relations constitute the core of the situation. These relations can be organised hierarchically to give us the flexibility when creating new semantic relation or managing existing relations. (Example: in (locatedIn, runIn, userLocatedIn …), support (envSup, deviceSup…)).

The situation is temporal and dynamic because of the change of its properties and the values of contextual dimensions. In Dey's meaning, the definition of current user situation can be found. This is totally agreed with our situation definition. The problem here is that it's not easy to use it. In order to allow designers to write only interesting situations, we introduce the notion of **situation type**. A situation type characterise user's current situation in some classes by following some predefined and pertinent properties. With each type of situation, we are interested in some properties of dimensions. For example, we have a learning situation type with the following interesting properties: "*properties of devices, knowledge of user, location and collaborators*". These properties constitute a property space of a situation type called *context view*. In fact, by using context views, designer can define all interesting characteristics which should be captured in a situation type. A situation type can be formalized as following:

SituationType*[name: String; entities: {Entity}; relations: {Relations}; constraints: {String}; context: {Properties}; intervalStabilization: int;]* .

A simple situation type gives us a description about a situation with its characteristics. A composed situation type can be defined by applying a temporal operator (*SEQ, PAR*) or a logic operator (*AND, OR, NOT*) on simple situation types. This type allows designers creating more complicated types regarding on the temporal dimension. This mechanism is useful to store situation historic.

Here is some example of type of situation: A learner is learning at school and using his/her PDA as learning supporting device.

LearningAtSchoolType[name: learningAtSchool; entities: {Learner}; relations: {in(Learner, School), do(Learner, Learning), use(Learner, PDA), intervalStabilization: 1 hour].

In comparison with a situation, an event has a shorter duration and it is significative for the adaptation process. An event is a set of when something important occurs in the life of a situation. Once the situation type in an event is valid and the constraints in that event definition are verified, that event will be launched. As we presented before, an event can be pedagogical event, so that lecturers can define the pedagogical event in order to adapt later in each occurrence of it.

An event can be formalized as following:

Event*[name: String; situationType: SituationType; constraints: {String}; occursTime: DateTime;]*

2.4 Logical architecture of a pervasive learning system

A pervasive learning system will provide some adaptive functionality for example: provide the learning objects adapted to user's knowledge, learning style, and physical context. In this type of system, the learning object will be recommended to user (it means that learning object will find the corresponding user to be delivered) more than be searched and user can learn it every where, every time. Learning continuity will be assured for each change of location or device or environment … In order to satisfy it, general system architecture is proposed (see Figure 1).

In this architecture, we distinguish two user roles: learner and author. A learner can receive an adaptive learning object and an author creates the model and learning objects. At low level, we have layers: ontology management and domain ontology which is static for one domain, and context dimensions which are dynamic and updated regularly by the data from captors. At higher level, we found three principal models: (i) user model which holds the relations towards domain ontology in order to represent user's knowledge. (ii) Pervasive learning object model (resource model) which is related to context model and user model. (iii) Context and situation model which regroups contextual information from many context dimensions. The highest level is system functionalities like learning, teaching, searching learning object, etc.

In this article, we focus on the pervasive learning object model presented in detail in the next section

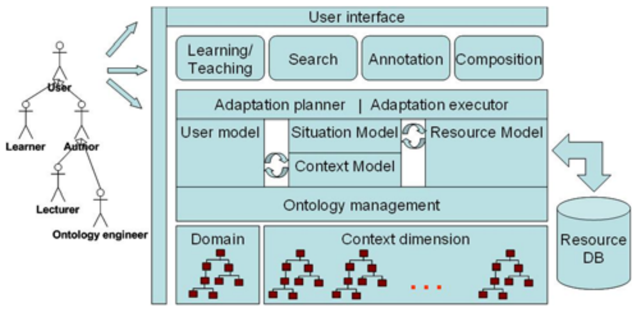

Figure 1: Generic pervasive learning system architecture

3. PERVASIVE LEARNING OBJECT MODEL

A pervasive learning object model is used to help users to manage and search for learning object in a pervasive system. This model must satisfy some requirements:

- *Accessibility:* Learning Objects should be indexed with learning and administrative metadata in order to facilitate searching and storing process.

- *Reusability:* Learning Objects should be reused as a part of other learning objects. Reusability reduces the development costs when creating new learning objects by the functionality of composition.

- *Interoperability:* Learning Object should be independent of devices and learning management platforms.

- *Conceptuality*: A Learning Object should be tagged with contextual metadata so that it can be delivered according to user's situation. In this case, a physical learning object will be allocated at run-time when the actual learning situation is known.

Regarding these requirements, we propose a learning object model which includes its organisation and learning object metadata. Organisation is pedagogical, structural aspect of learning objects. Existing metadata (like LOM, DC…) with extensions is used for indexing learning objects. Figure 2 show our proposition of learning object model.

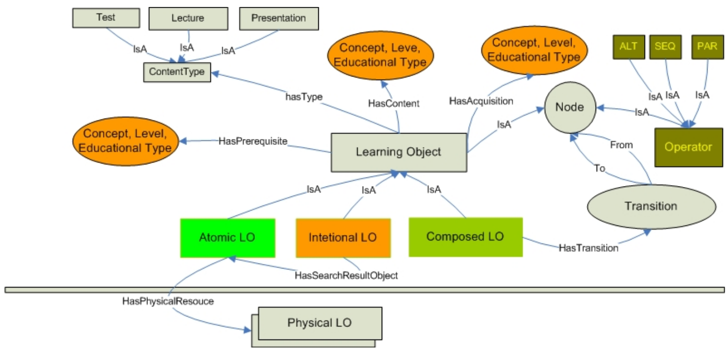

Figure 2.a: pervasive learning object model (part 1)

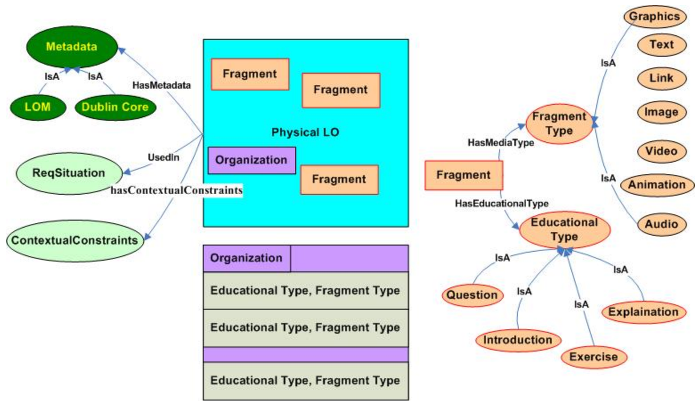

Figure 2.b: pervasive learning object model (part 2)

Learning object is divided into many levels in order to enhance its reusability, management. Each level has one or more metadatas for describing the objects of that level. Following is the description of each level.

3.1 Learning object description

A learning object is composed of different levels in order to augmenter its reusability and management. We distinguish six levels: fragment, physical object, atomic object, intentional object, composed object and pedagogical scenario. Each level has it own metadata. Theses levels are described in the following:

Fragment: a fragment may be a text, an image or a video (see Figure 2.b). This is the smallest element in our model. It can be expressed by metadata related to the file (e.g. jpeg, txt, pdf). The element of metadata of this type of object: *1) Fragment.source*: This is the source link by which we can find the content of fragment. 2) *Fragment.type*: Type of fragment like text, audio, video…3) *Fragment.educationalType*: Educational type of fragment like question, introduction, exercise, and explanation… 4) *Fragment.metadata*: This is the metadata of fragment.

Physical object: a physical object is an aggregation of many fragments which will be delivered to user through his/her device at one moment. Each physical object has an organisation of its fragments which is a list of couple (*fragment type, educational type*), for example {(video, introduction), (text, exercise), (image, example)} (see Figure 2.b). Metadata is used here to describe general information of the object using LOM and DC standards which provides the interoperability and reusability across multiple metadata standards.

In pervasive learning, it is necessary to annotate the intentional situation/context in which the learning object will be used effectively. This information allows adapting, selecting and classing learning objects according to current user's situation/context. Thus, besides general metadata, we add contextual metadata to describe physical objects based on the context/situation model. This allows overcoming the limitations of existing learning object standards describe in section 1. For example, one physical object normally has a specific type and format its content concerns a specific place (e.g. a museum) and it is only deployed in certain types of mobile device. The adaptation and composition processes will take into account this information in order to provide the best learning object to the user according to his/her situation. The contextual metadata contain information about the "best" situation for the learning object as well as its context view. The situation contains three parameters: 1) ***ReqSituation****,* a set of required situation types which current user's situation must satisfy in order to deliver this learning object. This attribute is very useful for learning object recommendation process. Once current user's situation is characterised by one ReqSituation type, the corresponding learning object will be recommended to user. In other words, ReqSituation is a trigger for delivering learning objects adapted to a current user's situation 2) ***TerSituation****,* a set of situation types used to indicate the end of an activity. When user's activity is for example to find out the current learning object, if the current user's situation satisfies TerSituation, the process of studying this learning object is terminated. *3)* ***ContextualConstraints*** to specify more details on the context of use of the learning object in that situation for example constraints on the size of screen of PDA or the speed of its processor…etc. It is a set of constraints on the context to which it is associated. This attribute is not mandatory when delivering resources but it's useful in order to build a list of learning objects according to the capability with current user's situation.

Atomic object: an atomic object is a physical object with semantic learning metadata (*prerequisite, content, acquisition*). (see Figure 2.a). This metadata is intended to help the process of adaptation and of composition of learning objects based on user's knowledge. Following is the elements of proposed semantic learning metadata:

Topic = {ConceptTopic|ObjectTopic}
ConceptTopic = (Concept, Level, Educational Level).
ObjectTopic = (LearningObject)
Prerequisite = {Topic, Topic, etc}
Content = {Topic, Topic, etc}
Acquisition = {Topic, Topic, etc}

ConceptTopic is a set of concept, level, and educational level. The concept is associated to the domain ontology. The level and educational level express the achieved degree on this concept. We defined: level: *high*, *medium*, *low* or *unknown* and educational level: *practice*, *introduction* or *exercise*. *ObjectTopic* is a reference to a learning object. That attribute is sub-class of Topic to express the relationship between learning objects. *Prerequisite* is a set of Topic which a learner must achieve before learning this object. *Content* is a set of Topic which the learning objects talk about. This is also a part of learning objectives of learning object. *Acquisition* is a set of Topic which a learner will have knowledge on after learning this object. This is also a part of learning objectives of this learning object.

Intentional object: an intentional object is an abstract learning object which is represented by a request (learning objectives) on semantic learning metadata. The simplest case is that an intentional object contains an element which is a set of domain concepts which represents the content of future learning object. At design-time, designers do not know which atomic object will be attached to this object, it's only known at runtime by the search function of system. This object enables dynamic selection, composition of atomic learning objects for a specific request or learning objective. The metadata of an intentional object:

IO.request = {String} *(IO: Intentional object)*

Composed object: a new learning object can be composed of existing atomic or intentional objects. Three composition operators are defined: ALT, PAR, SEQ. Operator links two learning objects to create new composed learning object (see Fig.1). As a result, this type of object allows reducing the efforts of creating new learning object. A composed object can be formalised as following:

CO = {LO|{LO, OP, LO}}

(CO: Composed object; LO: Learning object (atomic or composed or intentional); OP: Operator (ALT, PAR, OR))

Pedagogical scenario: a pedagogical scenario is defined as a special composed object in which all learning objects are intentional objects and they only contains learning objectives. It means that at the delivering time, the intentional objects are instantiated by atomically and dynamically searching the atomic or composed objects satisfying to the learning characteristics of its intentional objects. A pedagogical scenario is oriented to describe pedagogical information in a course by using the semantic learning operators and metadata. At design-time, it can be designed by lecturers who have a learning knowledge in the domain. At runtime, each user in each different situation has a different instance of that pedagogical scenario adapted to user's knowledge and current user's situation. A pedagogical scenario can be composed of intentional objects or other defined scenarios.

A pedagogical scenario can be formalised as following:

PS = {IO|{IO, OP, IO}|{PS, OP, IO}|{IO, OP, PS}, {PS, OP, PS}}

(PS: Pedagogical scenario; IO: Intentional object; OP: Operator)

3.2 Pervasive learning object model implementation

Our model is built as an ontology which aimed at providing multi level and interoperable description of learning objects. We implemented it by using Protégé (2006) which has a graphical user interface which allows creating ontology without knowing or thinking about syntax of an output language. We can create new learning object (atomic or composed) and associate it with the predefined situation types. Moreover, a learning object can be described by some attributes of LOM or Dublin Core metadata.

Figure 3 shows an overview of our ontology which contains two main parts of our model implementation: **Learning object** type like atomic object, intentional object, etc and **metadata** like DC, LOM and our extension metadata. By using Individuals tab of Protégé, instances of each type of learning object can be created easily.

After designing and creating graphically learning objects in Protégé, we transformed them into F-logic - the language of representation of our context and situation models. F-logic is a subset of First Order Logic and its declarative semantics (well-founded semantics) guarantees that results are independents of the sequence of the rules and the sequence of the statements within the rules. Moreover, F-logic allows inferring about facts, the attribute values and about ontologies its self, e.g., subclass relationship or available attributes of concepts. We decided to use this language because it allows writing a complex rule of inference and enables automated inductive and deductive reasoning about contextual information and also the relation between context model and learning object model. We used Ontobroker (2005) as our inference engine. This engine excels by background knowledge from these models. It exploits semantic structures by evaluating axioms about concepts, objects, relations between objects and attributes of objects.

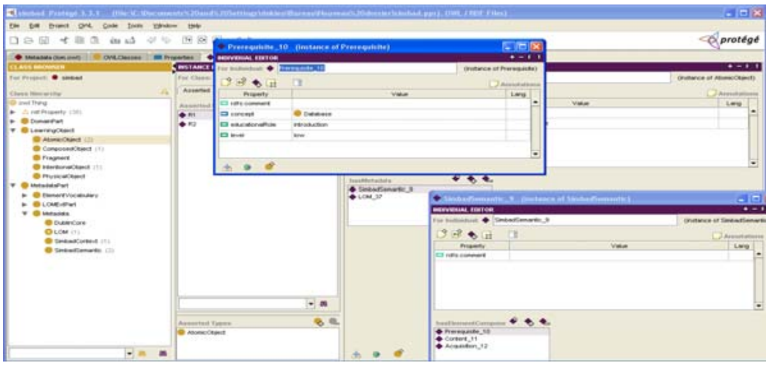

Figure 3: Graphical interface for creating and managing learning object in Protégé

3.3 Quality of learning object

Quality is considered generally as the requested properties that a learning object must have to accomplish effectively and efficiently its role. These requested properties are variable in each community, expert group, and organisation.

In pervasive learning, the aspect of quality is more important because of many different characteristics in comparison with traditional learning, for example distraction, mobility, and limited capacity of devices. Learners can learn at free-time and spare-time, they can read a learning text while they are walking, taking train. It means that the learning object is small enough that learners can consume it in small amount of time. Beside it, the system will take into consideration about all elements can make learners distractive during learning process because everywhere, every time learning. The comprehension about quality of learning object is still true but it must be refined and extended.

In our case, with extended semantic metadata (*prerequisite, content, acquisition*), some properties (Defude 2005) are defined to evaluate the quality of learning object. For example: the number of prerequisites must be less than 5. With composed learning objects, it must be existed one operator ALT in order to have at less two different learning paths that it is important for adaptation phase. The number of atomic Los in a composed LO must be less than 10...etc.

With the extension of our model to cover the contextual aspect, some contextual properties must be taken into account for the purpose of evaluation of learning objects. We applied the iterative process in order to assure learning quality. At first, experts (lecturers) can determine some typical types of situation in which learners can learn effectively. This task can be done semi-automatically by using data-mining techniques to analyse the trace of learners and to find interesting association rules. Secondly, some quality properties related with each type of situation can be defined by using these found rules. For example: An expert can say that learners can learn in the situation in which he/she uses PDA and be at home. The type of situation here is: *LearnerPDAHomeSituationType{use(Learner, PDA), in(Learner, Home)}*. The learning quality statement related to this situation type is: with all learning object which can be used in this type of situation must have a short learning time (e.g. 10 minutes) and rather in the format: audio and video (because learners can do other activity at the same time with learning, it'd better use audio and video).

All learning quality information enhanced our adaptation process. It's for the purpose of ranking learning objects and refining the request of learner in each detected type of situation.

4. ADAPTATION PROCESS

This section investigates on how to apply our pervasive learning object model to the adaptation process. The adaptation is the process composing of services: search/select/filter/class or transform in order to give user the best learning object based on current user's situation and knowledge

The adaptation process is composed of three steps: pedagogical filter, recommendation and preference filter (see Figure 4). Learner can interact with our system through two learning strategies: "push" and "pull". The push mode corresponds to course-base learning: Learner selects a course (pedagogical scenario); the system adapts the corresponding learning object to the learner knowledge level, preferences and current user's situation. The pull mode corresponds to goal-based learning: Learners formulates a query over concepts of the domain model and specifies the knowledge level they want to achieve for a specific role (e.g., "*introduction*", "*definition*"); the system composes "*on the fly*" one learning object satisfying these goal.

After receiving users' request, the system will select all pedagogical scenarios satisfying that request. A sequence of successive filters will be applied in order to recommender to user the best learning object corresponding to user's profile, knowledge and situation. The first one (*pedagogical filter*) checks the adequacy between learner's knowledge and learning object's prerequisites. The second (*recommendation*) is related to current user's situation. Current user's situation is built by the collected contextual information which comes directly from captors or indirectly from reasoning motors and after that it will be classified into the predefined types of situation. Upon the detected types of current user's situation, the system will choose the corresponding physical learning objects (*which satisfy the pedagogical scenario which is the output of the first filter*) which are annotated with those types of situation. The last one (*preferences filter*) orders the list of learning objects by applying learner's preferences in case that there are many learning objects after the recommendation. At the end, if there are still several learning objects, the system proposes them to the learner to choose one of them. The two last steps will be applied several times dynamically since the types of current user's situation change or new type is detected.

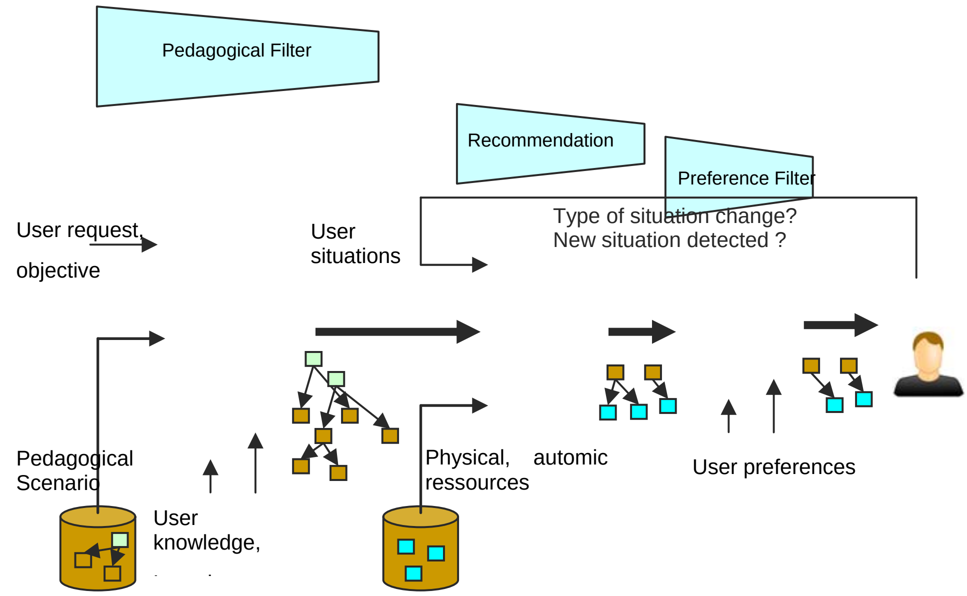

Figure 4: Adaptation process

All steps of adaptation process are implemented in F-logic rules. Here are two example rules (implementation of the *pedagogical filter* and *recommendation*) which allow eliminating all learning objects which does not satisfy to a learner's knowledge and recommending the best learning objects according to learner's situation.

5. RELATED WORK

The main objective of metadata in learning is to allow learning objects to be described, stored, indexed in a database and they can be retrieved or reused in different learning contexts. The most popular and wide-spread used descriptive frameworks are Cancore, IEEE LOM. Cancore (Cancore 2006) is a variant and a sub-set of LOM. LOM (Learning Object Metadata) is an interoperable standard aimed to foster the reuse of learning material for authoring lessons. LOM is based on meta-data models developed by IMS (IMS 2003) and ARIADNE (Vidal et al 2004) and uses a tree-like structure of namespaces to describe the data content and structure (Korneliya 2007). We decided to use the metadatas LOM as one part of description of our physical learning object. It also makes our learning model can collaborate with older learning system.

In terms of description of learning process, IMS-LD is an open standard which was created in 2003 by IMS/GLC (Instructional Management Systems Global Learning Consortium) (Koper and Miao 2007). It contains the learning process metadata as well as the learning resources. The description of learning process includes composite learning objects with its physical data assets. So that learning resources are statically assigned to learning process at design-time. Learning process describing in IMS LD can not adapt to different learners who have the different knowledge and profile. This problem also can be found in SCORM (ADL 2004) which aimed at creating and packing structured learning objects and makes learning objects reusable and interchangeable between learning management systems. To overcome this problem, we proposed the description of learning process as pedagogical objects which only contain the intentional objects. The atomic and physical learning objects which satisfy the description of intentional object and also adapt to each learner are only known at run-time. Each learner can have the different adapted learning path by means of the operator ALT in pedagogical object. This feature makes our learning process more dynamic.

Pervasive learning raises a new problem related with metadata of learning object. Few works (Chu et al 2005, Friesen and McGreal 2005, Kawarasaki 2004) research on the question which is how to describe learning objects in order to provide dynamic adaptability not only to learner profile or knowledge but also learner's physical context. (Friesenet and McGreal 2005) presented an extension of Cancore for mobile learning in which two suggested dimensions of informal situations include time and geographic location. Kawarasaki et al. (2004) proposes the extended metadata that describes end user device capabilities in order to deliver content over ubiquitous networks. In comparison with these studies, our situational metadata based on the notion: type of situation which describes the best intentional situation for deploying learning object is more general and easier to annotate. Moreover, we show how that metadata can be used through the adaptation process which enables pervasive learning described above.

6. CONCLUSIONS

In this paper, we presented our proposal to enhance learning object model by which a pervasive learning system can deliver learning objects at the right place, at the right time and by the right device. By defining many levels of abstraction of learning objects allows reutilising, creating, managing and adapting easily learning objects. Each physical learning object is associated with a type of situation in order to improve the appropriateness of delivering of learning objects. The adaptation process is also enhanced by three steps: pedagogical filter, recommendation and preference filter.

Our future works include applying this model in our prototype and evaluating it.

ACKNOWLEDGEMENT

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Turning Point: Transferring Data via Bluetooth® Technology

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ABSTRACT

The Turning Point project provided a unique opportunity to engage with youth in mobile learning via a digital mini film festival in September 2007and to research the transfer of data via Bluetooth® and BlueZone® technology to gain an understanding of this technology as a mode of transferring data to mobile devices. A Bluetooth® enabled computer facilitated the sharing of a variety of files and rich media with mobile devices in the classroom. The small one minute films produced by the students for the festival were displayed on the information hubs (iHubs) in the central business district of Melbourne were made available to share with the public via BlueZone® technology. This provided a unique opportunity to research these technologies and to gain an appreciation of the specific applications for streamlining the transfer of data to mobile devices to assist institutes, teachers, trainers, developers and students to manage educational content on a mobile device.

KEYWORDS

Mobile devices, PDA, information hubs (iHubs), Bluetooth®, BlueZone®, data transfer, students, filmmaking.

BACKGROUND

Mobile learning had been used extensively since 2006 to engage students in activities beyond the classroom by making the most of the facilities in the Melbourne central business district. Experience in mobile learning was gained with the use of the O2® XDA® IIs personal digital assistants (PDAs) through the development of educational content using a range of specific software that converts content for display on mobile devices and improving communications with students using short message service (SMS) and multimedia message service (MMS).

This expertise was extended in 2007 with filmmaking for mobiles as part of the Turning Point project funded by the Australian Flexible Learning Framework. This project provided a unique learner-centred opportunity to engage in mobile learning via a digital mini-film festival. The mini-films took youth culture to the streets as they were displayed on the information hubs (iHubs) in Melbourne. The films were available for sharing from the iHub to mobile devices via BlueZone® Bluetooth® technology. Through this rich media the Turning Point case study presented an ideal opportunity to research youth interaction with mobile learning data and data transfer to mobile devices.

iHub in the Melbourne CBD

THEORY

As the concept and practice of mobile learning and the mode of transferring data via Bluetooth® technology are still relatively new the project research focussed on the experimenting with the technology and gathering information on student interaction rather than testing any pre-existing theories.

The transference of educational content to the mobile device was the main issue the teacher experienced in 2006. As a consequence the aim of the Turning Point project was to research possible modes for transferring data to mobile devices. Technology-based learning environments, particularly mobile learning, have created a new set of issues which need to be resolved if acceptance of the technology is to be embedded and become mainstream in the vocational education and training sector.

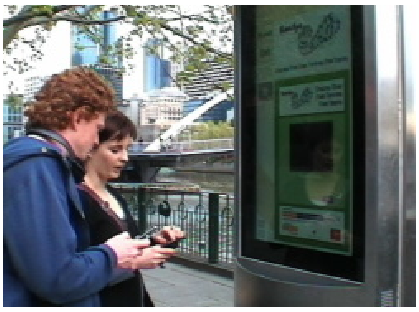
In the current climate of promoting mobile technology as an effective means for engaging learners the issue of transferring content to a mobile device has been glossed over. This issue has proved to be a problem that can take a considerable amount of time for teachers.

This issue is exacerbated by the limited battery life of mobile devices and no or limited opportunities to charge the device while in an educational environment. Mobiles and PDAs default to factory setting when the battery is exhausted; the device then requires operating software to be reinstalled before the student can access the educational content. This software includes, but is not limited to, Adobe® Reader®, Conduits Pocket Slides™, Macromedia® Flash®, e-book reader and writer and educational game applications.

Updating courseware materials on a device can require deleting and installing new content depending on the size of the memory and the availability of memory cards on the device. Updating software and content of individual students can take considerable time for the teacher.

The information hubs (iHubs) were installed in Melbourne for the Commonwealth Games in 2006. The iHubs are currently used to provide information on facilities available in the central business district, promote businesses and access to historical games and quizzes and have been used to enable people to receive information, vouchers and music files via Bluetooth®.

The use of Bluetooth® technology for transferring data to a mobile device was the primary technology researched in the Turning Point film festival case study. While Bluetooth® technology is not new, the use of Bluetooth® in the classroom to transfer files and images is not normal practice, indeed Bluetooth® capability on a computer is a relatively new option.



Downloading films via BlueZone® technology

The iHubs were selected as they are Bluetooth®-enabled using BlueZone® push technology which streams the data to mobile devices. The films were easily accessed via the touch-screen which enabled viewers to easily navigate to the festival site within two clicks on the selection buttons.

The iHubs are operated via a content management system that provides a direct link that manages the content on the 15-iHub network, but at the same time each hub maintains individual and independent capabilities. The touch-screens are totally interactive and thermal printing is also available for printing maps and vouchers. The content is refreshed hourly and data is collected on public interaction.

The digital film festival provided an opportunity to research the following key information on iHub technology and the transfer of data:

i. specifications and technical information including capabilities
ii. content creation methods
iii. the software required to develop content
iv. content management system including the Catapult system
v. content development for mobiles including file types, compression and resolution
vi. the Bluetooth® capabilities
vii. accurate data on downloads for research purposes.

The film festival was open to youth to enter a short one-minute video that was available on the iHub for users to access and download via Bluetooth® for one month, during this period data was collected for research purposes.

Bluetooth®, as a mode of transferring files such as text and images demonstrates distinct advantages over other data connectivity modes because:

i. The technology is readily available on a range of equipment.
ii. It is quick and easy to set up a Bluetooth®-enabled network.
iii. No costs are associated with using the technology.
iv. Transfer rate is fast and effective.
v. A text message is sent notifying learner that new content that is available.

Once a connection is established with equipment such as a computer or an iHub and a passkey is exchanged the mobile device is remembered for future interaction.

The films were compressed and converted to .3gp files to comply with requirements for display and transferring via BlueZone®. Each film was given a number from one to 10 for display on the iHubs.

The screen resolution on the iHubs exceeded the project team's expectations, considering the films were shot on mobiles and therefore pixilated if displayed full-size on a computer screen. The display was approximately 24cm x 24cm in size and was exceptionally clear on the screen. The sound quality was also exceptional with loud music from several of the films attracting the attention of passersby.

METHOD

The Turning Point project research was undertaken during the film festival trial phase and involved the collection of data to quantify interaction with the iHubs.

A iHub interaction survey was undertaken to document qualitative data on students and other user's mobile devices and their interaction with the iHubs. This survey recorded information from all of the students who participated in the initial stages of the film festival.

Quantitative data was also collected from the iHub on the BlueZone® interaction via the usage reports. This data recorded the opt-in and opt-out rates and the number of times a film was downloaded from the iHub.

CONTRIBUTION

Prior to the trial phase on the iHub the students used a Bluetooth®-enabled Apple® iMac® in the classroom to successfully transfer files and rich media such as images, film and music both from the computer to mobile phones and PDAs and from the mobile devices to the computer. The information was then shared from mobile to mobile which expedited the sharing of information in the classroom.

This transfer of data assisted to reduce the workload for the teacher and encouraged the students to take responsibility for managing information-sharing and updating the educational content on their PDAs.

Image transfer via Bluetooth®

BlueZone® uses Bluetooth® to create a wireless hotspot for mobile devices. This network can be local, national or global. Users are able to connect to mobile content portals and create private business or home networks; it is also possible to create mobile communities.

It is a communication medium that provides Bluetooth® technology for transferring data from one device to another using object exchange push (OBEX) protocol. This includes files such as text, images, audio and video. BlueZone® technology is:

i. readily available on a range of electronic equipment such as computers, mobile phones and wireless headsets. Some cars are now Bluetooth®-enabled
ii. quick and easy to use
iii. free-of-charge, particularly for the user, as there are no network cover charges
iv. available on demand at any time
v. fast and effective for transferring data
vi. scalable for any environment
vii. effective for communicating short messages
viii. effective for maintaining a permanent connection with the user
ix. effective for collecting data on downloads and usage patterns.

BlueZone® enables the user to set up a secure personal wireless area network between two devices such as a computer or portable device via a Bluetooth® chip that uses a microwave radio frequency in the spectrum 2.4 GHz to 2.4835 GHz range.

The normal limitation with Bluetooth is that a file or image can only be sent to one device from the master device at a time. The BlueZone® twin antenna can be scaled up to access seven handhelds per antenna, enabling the system to connect to a total of 14 Bluetooth®-enabled mobile devices. The devices can then be queued to receive data at the same time using the OBEX push technology.

The Bluetooth® connection wizard on the master computer or mobile device which acts as the lead agent steps the user through the process of setting up the network. On the iHub, BlueZone® sends a pop-up invitation to receive data from the iHub to mobile devices. It is possible to edit this message to send specific information to the user. If the iHub requests a passkey, the system is set to accept the default Bluetooth® 0000 passkey.

The receiving mobile device must first have Bluetooth® on and set to 'visible', 'show', 'shown to all' or 'find me' to receive the 'call to action' invitation. The user then opts-in by accepting the data or opts-out by selecting 'No'. If the user accepts the invitation the file is transferred to the 'inbox', the 'gallery' or the 'picture' folder depending on the type of data being transferred and the receiving system on the device.

BlueZone® program settings can be configured to have either an opt-out or no opt-out option. In the opt-out option a user can decline the invitation and they are not contacted again for a designated period of time. This timeframe can be customised. If a user declines an invitation in the no opt-out option they are sent repeat invitations when they come back into mobile range. The no opt-out option is a preferable setting if the transfer of data is interrupted, or if the user cancels the transfer or if they move out of range as this means that the device is remembered and offered further files in the future.

The mobile device must be able to receive the data being transferred; some mobiles are not able to receive rich content such as video or java applets. Information can be sent to receptive devices in the following formats:

i. contact details and calendar updates
ii. personal files and emails
iii. software, games and quizzes as a java applet
iv. graphics such as .gif and .jpg files
v. podcasts, videos and ebooks
vi. m-vouchers such as a redeemable gift

The iHub BlueZone® high-speed server is located in Sydney; it streams content to the antenna in the iHub via broadband-speed internet connection. The antenna then transfers the content to the mobile device via Bluetooth®. The iHubs were recently upgraded from Bluetooth® 1 to Bluetooth® 2 with an enhanced data rate antenna. The films for the festival were hosted on the server in Sydney.

The BlueZone® antenna requires a personal computer and a router to operate and used without a touch-screen it becomes a portable system that can be set up in any environment indoors or outdoors. With training it is relatively easy to set up a network and start transferring data to mobile devices.

The optimal range for transferring data is 100 metres, but the actual range is limited to 5–10 metres, depending on the mobile device receiving the signal. The data transfer rate for any Bluetooth® device is 10–100KB per second, depending on the receiving device, the distance to the handset or the number of devices in range. Inclement weather will also affect the signal.

Currently, BlueZone® can only be used to push data to a mobile device; however, it would be possible to include a Bluetooth® dongle with an additional server to receive student content such as messages and assignments. It is envisaged that in the future Bluetooth® will support this reciprocal capability.

Content sent to a mobile device is automatically repaginated to fit the receiving device's screen size, or if a device is not recognised, information is sent for a generic screen size. The films which were sent to mobile devices played and displayed successfully on the screens of a range of mobile phones during the trials in September and October. Not all mobile phones and PDAs were receptive to content from the iHubs which is an inclusivity issue that may be overcome when Bluetooth® technology standards are revised and included as a standard feature in mobile devices.

EVALUATION

iHub interaction survey

Turning Point team members, students and members of the public were invited to participate in the iHub interaction survey. They were asked to complete the following form to facilitate the collection of qualitative data on the type and model of mobile device they used, if they received a call to action invitation and if a film(s) was successfully downloaded to their mobile.

Information on 19 different brands and models of mobile devices was collected from the surveyed participants. **Table 1** documents the brand of mobile, the model if known, if an invitation was received and if a film was successfully transferred and displayed on the mobile.

No	Mobile	Model	Invitation	Film transfer
1	PDA	O2® XDA®	Yes	No
2	Nokia®	N95®	Yes	Yes
3	Nokia®	E65®	Yes	Yes
4	Nokia®		Yes	Yes
5	Nokia®	N50®	Yes	Yes
6	Nokia®	N80®	Yes	Yes
7	Nokia®	6280®	No	No
8	Motorola®	V3 Raza®	No	No
9	Motorola®	V3®	Yes	No
10	Motorola®		Yes	Yes

11	Motorola®		Yes	No
12	Samsung®		Yes	No
13	Samsung®		No	No
14	Samsung®		Yes	No
15	Samsung®	New model	Yes	Yes
16	Samsung®	E250®	No	No
17	Sony®	2310i®	Yes	No
18	3Phone®		No	No
19	LG®	TU500®	No	No

Table 1: **Data on mobile phone invitation and film transfer**

Of the 19 different phones that participated in the trial 13 received a Bluetooth® invitation and only seven successfully downloaded a film from the iHub.

When the film was successfully transferred it was immediately available for viewing on the mobile device. This indicates that interoperability is possible between the devices but there are residual issues which need to be resolved.

Successful transfer of film

Initial results during the trial period indicate that later models of mobile devices are more receptive to Bluetooth® signals and the transference of data than older mobiles. The sample was too small to extrapolate specific data on particular brands and models.

It is worthwhile noting that different results were experienced by some users, for example, amongst the Motorola® users, two participants using the same model experienced different file transfer results. This may be the result of one participant inadvertently opting-out of the invitation or moving out of transfer range.

It is incorrect to assume that young people have the latest technology in their pockets. Three of the phones used in the trial were not Bluetooth®-enabled, a significant number were base models and several phones were damaged and required repair.

BlueZone® usage report

Data was collected via the BlueZone® server which recorded the number of times a Bluetooth® call to action invitation was sent to a mobile device and the number of times the films were transferred to a mobile device via Bluetooth®. This quantitative data was collected during the digital mini-film festival from 17–30 September 2007.

One of the films playing after being downloaded

The one-minute films on the server were numbered from one to 10 and streamed from the server in this sequence and not, as was intended to occur, when a film was being viewed on the iHub. BlueZone® pushes data files out as queued on the server; the system is not designed to enable specific files to be selected as required.

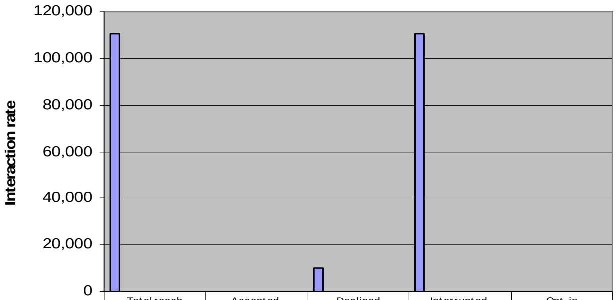
It was envisaged that this information would be used to judge the winner of the film festival. Initial discussion for hosting the festival on the iHubs negotiated a voting panel on the maxisite to enable viewers to have their touch on a button recorded when they selected the film they liked the most. This proved to be technically difficult to achieve in the timeframe available before the festival start date. As a result, the films were distributed to four professional filmmakers to ensure unbiased judging to select the winners of the film festival entries.

The usage report includes the following information on the ten films:

i. the total number of mobiles reached by the Bluetooth® signal
ii. the number of times the Bluetooth® invitation was accepted and the film downloaded from the iHub
iii. the number of times the Bluetooth invitation was declined
iv. the number of times the signal was interrupted

v. the opt-in percentage (calculated on the number times the signal was sent and the number of times a film was downloaded).

The following graph, Table 3 documents the interaction period for 17–30 September 2007. Because the films are queued from video one to 10 on the server, video one was automatically transferred first. This automatic transfer restricted the user's ability to choose content; consequently the data report does not reflect viewer preferences for the most popular film.



	Total reach	Accepted	Declined	Interrupted	Opt-in
Video1	110,428	158	10,196	110,270	1.53%
Video2	137	30	48	107	38.46%
Video3	30	7	11	23	38.89%
Video4	6	4	1	2	80.00%
Video5	4	2	2	2	50.00%
Video6	2	1	1	1	50.00%
Video7	1	1	1	0	50.00%
Video8	1	1	1	0	50.00%
Video9	1	1	1	0	50.00%
Video10	0	0	2	0	0.00%

Bluetooth

Table 4: User interaction with iHub 17-30 September 2007

The data was collected by the seven fully functioning iHubs and the eight iHubs that had sustained damage to the screen or suffered from power problems as the BlueZone® signal was still being transmitted from the iHubs. This and the fact that multiple invitations would have been sent to handsets within range of the iHub accounted for the high 'total reach' figure. Many handsets do not notify the user that an invitation to transfer data has been received, as a consequence many passersby would have been oblivious to one or repeat invitation messages.

CONCLUSION

The Turning Point project was the first time a number of films were hosted on an iHub and streamed via Bluetooth®. The project provided a unique opportunity to trial the technology and test the system, research public interaction and to identify possible problems before the technology is implemented for transferring educational content to meet the specific needs of individual students, teachers and educational institutes.

To date, setting up the content and the initial trial phase provided valuable information for the project team members and both companies involved with the technology. The problems project members encountered provided an opportunity to learn more about how the technology operates and how people engage with the technology.

BlueZone® interoperability

The interoperability issue is a more complex issue to resolve before transferring data files to all mobile devices is possible. The Flexible Learning Frameworks E-standards and M-standards note that interoperability and usability are crucial to ensure accessibility, particularly in an educational environment. (O'Connell et al, 2007 pgs3-4). The BlueZone® data transfer technology is designed to push out messages; it does not support a 'library' of content that is available for users to choose which file they would like to download.

The project has given team members valuable information on the requirements needed to ensure this technology meets both the E-standards and M-standards of interoperability, usability, manageability, accessibility, durability, scalability and affordability to ensure content meets 'baseline' delivery contexts and maximises quality and usability (O'Connell et al, 2007 pgs 3-4). Interoperability may not be possible as it is estimated that there are over 3,000 different types of mobile devices and each device has its own specifications that may cause problems with connecting to a BlueZone® network.

The initial iHub interaction survey documents the low call to action invitation rate and the even lower Bluetooth data transfer rate. The reasons for the low transfer rate are as follows:

i. the protocol used to establish the network and transfer data

ii. the user may be unaware of the invitation to receive data.

iii. the age of the mobile device

iv. an inability of some mobile devices to accept rich media files.

The Apple® iPhone®, the Blackberry®, smart phones and some PDAs do not accept the BlueZone® invitation to share files as the device does not support OBEX push protocol. Apple® iPods® are not Bluetooth®-enabled and the Windows Media® system also has limitations as an operating system as it restricts the transfer of data.

During the film festival the O2® XDA® IIs PDA received a pop-up message requesting a 'passkey', on entering the generic Bluetooth® passkey 0000 the PDA did not receive further instructions nor was any data transferred to the device. However, during the 2008 Mlearn conference, once the connection was established the PDA received the files without further problems.

Both BlueZone® and Bluetooth® technology support the transfer of data to mobile devices. The use of this technology has the potential to meet the needs of the students, the teachers and managers of educational institutes by creating dynamic learning environments that support mobile learning.

BlueZone® communication potential

As a discreet system within the Institute; BlueZone® technology has the potential to create a new and dynamic communication system. A number of strategically located campus hotspots that push information to staff, students, and visitors on campus could be designed. A vital component of this technology is that it does not require contact details, there are no costs associated for the user, it is scalable and it can be directed to specific locations. The technology can be stand alone or it can be incorporated into a touch-screen kiosk.

BlueZone® has the potential to enrich the campus experience for students by sending global messages such as animated welcome messages and updates, travel information, quizzes, games, recipes, free vouchers, informative video files or podcasts or emergency information videos, information on student activities and happenings in the city. These dynamic messages have the potential to encourage students and make them feel welcome and supported. It is recommended that an induction program or training be undertaken to ensure that users know how to use Bluetooth® technology and that mobile devices are successfully connected to the BlueZone® network.

The process for selecting and sending data is as simple as browsing for a file and activating it on the BlueZone® server. A resource collection of prepared data such as animations, videos, podcasts, and m-vouchers could be used or a template that quickly facilities the production of animated .gifs, images and photographs would simplify the production of the data.

Bluetooth® advantages

Bluetooth®-enabled computers are envisaged as a separate system that is managed locally within the library or the classroom by the teachers and the students as a library of references, activities and assessment tasks. Students would be able to select the file they require and transfer it to their mobile device via Bluetooth®. They are also able to submit work to their teacher. This system has the following advantages over other wireless systems:

i. Security is a minimal issue with content being stored within the Institute's computer network.

ii. A student accesses only the nominated file on the computer, this is restricted to one file at a time.

iii. It supports collaborative learning as it facilitates the sharing of work files.

iv. It is environmentally friendly as it facilities the paperless sharing of information.

SCENARIO USING BLUEZONE® AND BLUETOOTH® TECHNOLOGY

The following outlines a possible scenario for the use of both BlueZone® and Bluetooth® technology in an educational environment.

During orientation week students participate in an induction program where they are advised to activate Bluetooth on their mobile device and to check that they are connected to the BlueZone® hotspots on campus. Within seconds they receive an animated .gif welcoming them to the Institute. They appreciate the message and several students set the .gif as wallpaper on their phone.

At the end of the day three of the students receive another animated .gif offering them a free cup of coffee which can be redeemed the next day while the others in the group received a 'Goodbye, hope you had a great day' message. The students find out that messages are sent out each day with a joke, a quiz, updates on what is happening in the Recreation room and several of these are random m-vouchers that offer free gifts. The students begin to look forward to these messages as they make the day more interesting.

In class the students are given activities to complete on their mobile phones This work is sent as a Word document, a PowerPoint presentation, an ebook or a video file to their mobiles via the Bluetooth®-enabled computer in the classroom. Students are able to catch up on work selecting the file they missed and transferring it to their mobile device. They are also able to send work to the teacher by transferring files from their mobile device to the computer. This is great as they don't have to pay to have their work printed and they are saving power and paper.

In the second semester students complete work placements and it is during this period that Jason misses out on vital information that he needs at work. He quickly calls in to the library at TAFE and downloads the video file he needs to catch up. He can replay the video and practice before he is assessed the following week.

Two weeks later, while the students are studying on the second floor of the library, a fire breaks out in a rubbish bin near the lift. The second floor is filled with smoke and they are unable to leave the area via the lift. They are advised by the message they receive on their mobile phones to evacuate the building via the exit at the back of the building. The message contains a map marking the location of the fire escape. All students are able to leave the building safely. The message was particularly effective as it was sent via the BlueZone® hotspot located within the library and was able to target the students in the vicinity so they received the message within seconds.

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Digital Mini Film Festival: a Framework for Mobile Learning

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ABSTRACT

The Turning Point Digital Mini Festival for youth is a framework for engaging reluctant learners via a program of filmmaking and event management. This action learning project explored the relationship between the convergence of technology and learning by utilising the student's interest and skills in using mobile technology to produce films for the festival. The films, which were scripted and acted by the students, were to be no more than one minute in length and tell the story of a life altering turning point. The students hosted the festival setting up a website to advertise and receive entries from round Australia. With support from the City of Melbourne council the films were hosted on the information hubs (iHubs) on the streets of Melbourne and were available for sharing via BlueZone® technology to passersby using Bluetooth® enabled devices. Through the student engagement the project researched the essential role of culture and mobility plays for the Generation Y and the importance of distribution methods for the learner and the teacher for self managing digital content. Research was undertaken to provide information on youth attitudes to mobile learning.

Author Keywords

Mobile learning, mobile devices, curriculum design, applied learning, student engagement, learner-centred, filmmaking, information hub (iHub), youth culture.

INTRODUCTION

The action research reported in this paper represents an applied learning project that utilised high quality mobile learning in the post compulsory vocational education and training sector. The paper discusses the Turning Point project as a framework for engaging students in a hands-on learning project that takes the students out of the classroom to engage in real life learning in the central business district of Melbourne. It explored the attitudes of students to mobile learning and discusses the issues of designing a curriculum that embeds filmmaking and mobile technology in a program that provided a bridge from text to context.

Mobile learning was implemented in 2006 to engage students undertaking the senior Victorian Certificate of Applied Learning (VCAL) by utilising their skills and interest in mobile technology. The students were provided with an O2 Xda IIs personal digital assistant (PDA) for use while enrolled in the program. Mobile learning was used to encourage and support students, who in the past found learning in a traditional educational environment difficult, by providing access to learning materials in a visual and portable format that could be viewed and reviewed as required.

Students

The Turning Point project engaged students who are disaffected learners at risk of leaving the education sector. The Victorian Certificate of Applied Learning (VCAL) offers students in the 15-20 age group a program that engages them in hands-on activities where they are able to learn from experience. Many of these students see little reason to spend time in a classroom; they demand relevant educational activities that can be applied in work situations. These students positively respond to opportunities to learn in real life situations and will engage with mobile learning that supports:

- close communication with the teacher and other members of the class using short message service (SMS) and multimedia message service (MMS)
- provides access to educational content that can be reviewed on demand, customized or manipulated to meet individual learning needs
- enables students to create educational content
- enables students to record a problem and seek assistance
- enables students to document their learning outcomes

In 2007 the Australian Flexible Learning Framework funded the Turning Point project as a new practice in flexible learning to research both learner engagement and the transference of data to mobile devices using Bluetooth® technology. The project provided the ideal framework for a learner-centered curriculum; it facilitated the opportunity for students to film their scripts and share their films via a digital mini festival for youth on the streets of Melbourne. Mobile learning was used to actively engage students in activities beyond the classroom by making the most of the facilities in the Melbourne central business district to set up meetings with business professionals to seek sponsorship for the festival.

THEORY

The main objective of the Turning Point project was to create a stimulating learning environment for students using mobile media and digital technologies. The research explores the general hypothesis that mobile devices will encourage youth to learn if the context is dynamic and culturally-centred. The project also aimed to assist teachers by proposing a solution to the problem of transferring and updating educational content to a mobile device.

The application of mobile learning is growing in the vocational education and training sector and as a consequence there is a need for teachers "to think through the underlying principles on which we base educational activities" (Hein, 1998, p. 15), particularly mobile learning which is still being challenged in some school based learning environments as a disruptive element in the classroom. Sharples, Taylor and Vavoula proposed a theory to "re-conceptualise learning for the mobile age" that recognises the essential role that communication plays in learning. This communication not only provides access to educational content, it supports the student, provides the means of communicating with peers and teachers and most importantly it provides the tools to create, publish and celebrate their culture.

Hein proposed three theoretical areas: the nature of knowledge, a theory proposing how people learn and a theoretical basis for teaching practice. This basis ensures knowledge is obtained through an active learning process that engages the learner requiring them to reflect on what they are experiencing. This reflective process was captured in a series of filmed interviews that utilised the Appreciative Inquiry questioning technique. This approach encouraged students to reflect on what they were experiencing and to use this experience to project themselves into the future of mobile learning.

Students downloading films from an iHub

The method of encouraging students to construct their learning in a supported learning environment provides a collaborative and consultative social constructivist approach for learning (Vygotsky, 1978). The project provided a rich learning environment by facilitating access to experts in the field of filmmaking and distributing digital content on the iHubs via Bluetooth®. The students gained skills and knowledge that enabled then to confidently collaborate to produce each others films providing a valuable "socio-cultural system" (Sharples et al, 2005. pg 7) to support their learning.

Mobile learning makes the most of the student being mobile as well as providing access to mobile devices, (Sharples et al, 2005). O'Connell and Smith recommend that this principle should be used in conjunction with making the most of being on location: in formal and informal settings; utilising the outdoors, the home and the workplace. (O'Connell et al, pg 3) The production of the films and hosting the festival provided this dynamic learning environment as the students explored a range of scenarios for their films.

METHOD

The Turning Point digital mini film festival was a multi-focused project that aimed to record the action learning process the project team undertook; this involved documenting the filmmaking with and for mobile devices, how iHubs work, the process for developing content for display on an iHub and to research student responses to mobile learning. The transfer of data via Bluetooth® and BlueZone® technologies and the specific applications for these modes of transferring data and this is the subject of a second paper entitled Turning Point: transferring data via Bluetooth® technology.

Digital Mini Festival

The medium of film, which is a familiar entertainment format for this student cohort, was selected as the mode for engaging the students; the process of filmmaking supports collaboration and provides opportunities for leadership. The action learning format of the film festival researched youth engagement by facilitating opportunities to access mobile and filmmaking technology. The information was collected as qualitative data and documented the learning as a digital story and written report.

iHub in the Melbourne CBD

iHub Technology Research

Initial research was undertaken through a process of consultative interviews from April through to August to ascertain the workings of the iHubs. The iHubs incorporate two separate technologies. Digital Spark manages the physical structure on the streets of Melbourne; this includes the touch-screen and the operating system that stores and displays the information.

Aura Interactive manage the BlueZone® technology that streams the data to Bluetooth®-enabled devices that pass within range of the iHubs on the streets.

The main use of the touch-screen is to provide visual and aural information to the user; it is the main communication portal for promoting new content and contains information on how to access and download the content encouraging the user to interact with the technology. The user can then navigate the content by using the 'Touch here' button to search for more information.

Appreciative Inquiry

The students were interviewed at regular intervals to ascertain their engagement with mobile devices as a tool to support learning; this encouraged the students develop oral skills, gain expertise in responding to questions and to encourage them to reflect on their learning and the use of mobile technology. The Appreciative Inquiry methodology underpinned the interview questions as this questioning technique encouraged the students to reflect on past learning experiences and subsequent questions required the students to build on this experience and envisage what is possible in the future. The Youth Engagement film documents the student's reactions to the questions.

Appreciative Inquiry (AI) means gaining understanding through positive inquiry, it implies a quest for new information and understanding through a process of asking questions (Cooperrider et al, 2007 pg 3). AI encourages an open forum for all team members to discuss issues and seek solutions that change current practices through the implementation of positive change that will have long term benefits. AI fits an adult learning environment as it encourages an appreciation of others experience and values the knowledge that experience brings when implementing change.

AI questions move from closed yes/no questions to open why, how and what if questions, this process of inquiry stimulates reflective thinking and encourages more creative responses to the questions. Dialogue about the strengths, successes, values, hopes and dreams is itself transformational. The questions must be constructed in such a way as to encourage a positive response and must not put the interviewee on the defensive. (Cooperrider et al, 2007, pg 4-5).

Touch-screen use

It is a powerful questioning technique stimulates curiosity and encourages more creative responses to questions. Reflective thought processes provoke deeper understanding of an issue as it involves analysing the issue from a personal perspective, this deeper understanding is more likely to stay with the person as they have invested a personal and emotional response to the question. This process of gaining meaning encourages ownership of the issue. The following is a sample of the questions:

- What was your initial reaction to mobile learning?
- What did you learn from the experience of using mobile technology to access course materials last semester?
- Describe what mobile learning means to you?
- What for you is the best part about mobile learning?
- Describe a situation where you see mobile learning as being really useful tool.
- How can we improve on what we started last semester?
- What do you see as the future for mobile learning?

As the students are typically disengaged from the traditional learning environment the interviews aimed to research individual responses to the applied learning curriculum and their engagement with mobile learning. The interviews started with supported group discussions to build the confidence of the participants and finally progressed to a Big Brother diary room type scenario. Initially the responses were short and uninformative but as the students become more confident with the camera, and experienced and knowledgeable about project their responses become more informative.

CONTRIBUTION

As a framework for mobile learning the Turning Point project encouraged students to critically evaluate films, learn the language of cinema and gain the specific filmmaking skills and techniques of making films for mobile devices. The student team members participated in the Young Achievement Australia Business Skills Program™ to establish an event management company. The students experienced business management first hand and as a result they gained self- esteem, leadership and teamwork skills.

The Turning Point project enabled the teacher and the students to gain valuable digital literacy skills and to engage with the process of filmmaking during two filmmaking workshops. The workshops focused on scriptwriting, storyboarding and included filmmaking techniques specifically for mobile devices. Seven films were produced as a result of these workshops and these were submitted for display on the iHubs with the external entries.

The festival theme was a turning point - that pivotal moment that changes everything in a young person's life. The selection criteria for the festival specified that the films be:

- shot on a mobile device such as a phone or PDA
- no more that one minute in length.

The criteria for editing a film was amended after it was realised the microphone for recording sound on a mobile device was inadequate for shooting the films. In hindsight this improved the quality of the films as it enabled participants to create more sophisticated films and engage the viewer at the iHub for a longer period of time. This is critical for the transfer of the content to a mobile device to take place.

Mobile filmmaking

The students participated in two workshops a film lecturer from the Victorian College of the Arts. The first workshop involved tips and hints on shooting techniques, camera angles and depth of field and an analysis of a series of short films. The second workshop on editing techniques provided the students with the opportunity to edit a professional film.

A media lecturer from RMIT who specialises in creating films using a mobile device gave the students an insight to the importance of planning a film to tell the story this involved the creation a storyboard and writing a script to tell the story and build the suspense.

Editing the films

Initial film trials with the O2® XDA® PDA and other mobile phone including Nokia®, Sony Ericsson® and Motorola® revealed the microphone as inadequate for recording conversations taking place with the actors. This problem is the major drawback for creating films with mobiles. It is possible to record footage or narrate the commentary while recording the film. This is a complex task to complete with a mobile device. The other solution is to edit the film and add recorded voice or music or to add text to the images. The solution is to edit the film and add recorded voice or music or to add text to the images. This enabled filmmakers to create more sophisticated films which improved the standard of film entered in to the festival. Films could be submitted to the festival via email in the following file extensions:

- .WMV
- .MOV
- .AVI
- .MP4
- MP3
- .3GPP

The films were compressed and converted to .3gp files to comply with requirements for display and transferring via BlueZone®. Each film was given a number from one to ten for display on the iHubs.

iHub technology

iHub content is managed from a central server located in Melbourne; it distributes the information to all iHubs and collects the interaction data.

The operating system is similar to an intranet; it is possible to have multiple maxisites on the server. The response to touch is fast; however, on one iHub the sensitivity of the screen was out of sync with the button which was disconcerting for the user.

Servicing an iHub

Maxisite can be a single media file or a group of media files playing on a play list rotation while the user is in the maxisite area. The festival films were converted to .3gp files and compressed to an average 600KB file size. The data transfer rate was approximately one minute for each film, again depending on the handset that was used. It was important to keep file sizes small to facilitate a fast download time as people will not stand and wait for long periods of time for content to be transferred.

An iHub contains a personal computer, a router, wireless broadband connection, the BlueZone® Bluetooth® antenna streaming technology, a thermal printer and a power supply. The printer enables the user to print a map or for vouchers to be supplied from the iHub. This strategy has been used as part of a publicity campaign.

The equipment is housed in a stainless steel cylinder and can be serviced by opening the front panel that contains the touch-screen. An information hub is not restricted to this size or shape. Touch-screens are now available in taxis that support booking accommodation, tours and for viewing short videos. New interactive developments in touch-screen technology will enable iHub technology to become readily available, for example, as table tops and mobile devices.

The touch-screen, located on the front panel, is protected on the back by a sophisticated filtering system to protect the equipment from city grime and the impact of the weather.

Touch screen protective covering

Touch-screens are vulnerable to impact damage and susceptible to system failure due to everyday use and environmental damage.

The primary causes are vandalism and environmental damage sustained on the streets. It was disconcerting to discover that of the 15 iHubs located on the streets of Melbourne, only seven of the units were working effectively at the time of the festival. Touch-screen problems accounted for six of the non-working iHubs. Two were without touch-screens due to a fractured screen and four were not operational due to touch-screen faults. The screens are imported from New Zealand and have a minimum replacement time of one month.

Youth engagement film

The aim of the youth engagement film documents the student's thoughts on mobile learning as they respond to key questions using the Appreciative Inquiry methodology. As the students were disengaged from the traditional learning environment the interviews sought to research individual responses to applied learning curriculum and their engagement with learning beyond the classroom. Through this process the students contributed to our understanding of what youth gain when engaged in mobile learning.

Appreciative Inquiry methodology was used for the interview questions as this questioning technique encouraged reflection on the best aspects of their past learning experiences, then subsequent questions required the students to build on this experience and to envisage what is possible in the future.

The Interviews started with supported group discussions to build confidence and progressed to close a range interview format as the students become more confident and familiar with the camera and more knowledgeable about project and as a result their responses become more informative.

EVALUATION

Mobile filmmaking

The project achieved the following outcomes:

- a dynamic learning environment for students
- specific information on shooting and creating films for mobile devices
- the design and production of a logo and website
- the production of seven one minute films
- a digital mini film festival for youth on the information hubs on the streets of Melbourne
- insights into youth engagement with mobile devices
- the production of a Youth Engagement film documenting the project.

A close up shot to capture the action

Mobile filmmaking uses similar techniques used by original filmmakers in the days of silent movies. This is primarily due to the small screen size, the current small pixel size of cameras, screen resolution and the recording limitations of the microphone. Specific techniques for mobiles include:

- Use close up shots with cut away to medium range. Detail drops out in long range shots
- Use close up shots of main action and characters and keep in the centre of the screen to emphasize the action
- Use minimal panning and zooming, mobiles do not use as many frames per second as video cameras
- Overstate content e.g. emphasize expressions on faces

- Use a minimal number of colours and use colours that are bold and bright
- Use strong lighting or bright sunlight. Night light is greenish and pixilated
- Use slow hand movements when filming, panning and zooming
- Use a tripod or an arm rest to prevent shaking.

iHub technology

The sound quality was exceptional on the iHubs; however, the sound file dropped out for approximately the last five seconds of the film. It was suggested by the iHub technician that the reason for the sound dropout is that the large-file maxisite takes up a lot of memory to run with the Catapult system and all the backend processes that Windows® XP requires to operate and that this consumes the memory on the central processing unit. A possible solution to this problem was to reduce the number of videos to six or eight.

The actual screen displaying a selection of the films

A problem with the supply of power to the iHubs was also an issue during the first weeks of the film festival in September. Digital Spark was aware of the problem and undertook the appropriate action to rectify the power supply situation.

During this period BlueZone® was active on all of the iHubs sending out Bluetooth invitations to download the films but without the touch-screens in operation to explain the purpose of the invitation the opt out rate was very high.

The large interactive touch-screen provides an interface that is 3852cm x 5762cm (W x H) and is backlit which assisted with the display of content particularly at night.

The content on the screen, which is called a maxisite, is developed using Macromedia® Flash® and exported as Macromedia® Shockwave® (.swf) files that run as a child flash application to the parent iHub application. The maxisite has a frame rate of 24 frames per second (fps).

The Flash® .swf file runs externally and is independent of the iHub. All of the maxisite content and navigation is also independent of the iHub. The iHub simply controls the maxisite on and off state on the touch-screen.

A button from the main menu links directly to the maxisite. The user navigates the maxisites by touching a 135cm x 100cm (W x H) button which has a static image .jpg with an overlaid ‘Touch here’ button that takes the user to the selected maxisite. Touching the name of the film or the film image opened the film for viewing on a larger new browser window. The iHub uses FSCommands to keep track of and record button touches throughout the system for reporting means.

Table 5, following, outlines the specifications for the developing content on the iHubs.

Content	Dimension W x H	Format	Notes
Idle Page	3852 x 5762	.jpg	Static poster describing the event, includes Bluetooth® logo and a call to action for downloading
Menu Button	135 x 100	.jpg	Floating button (logo) which acts as a touchable link to the maxisite
Maxisite	573 X 877	.swf	A Flash® menu plays individual videos. When touched videos no larger than 320 x 240

Note: specifications subject to change depending on the size of the iHub and the touch-screen.

Table 5: iHub content specifications

It was anticipated that the winner of the film festival would be selected through the data collected on public interaction which recorded the film that was downloaded the most during the festival, however, the data revealed the films were downloaded by sequence and not as viewed. As a result, the films were independently judged by a panel of four professional filmmakers, the winner being selected by the highest score.

Youth Engagement film

The students benefited from their engagement with film as producers and actors, the practice interviews also gave them the confidence to face the camera and speak knowledgably about mobile learning. The final take for the Youth Engagement film documents the following sample comments made by the students on mobile learning:

- students feel valued when given access to valuable mobile technology
- the use of mobiles in the classroom eliminated the need to send furtive text messages in class
- access to resources was improved
- students enjoyed accessing the resources provided in the central business district of Melbourne
- communications with the teacher and other students was crucial to developing self esteem and supporting teamwork
- course content is easier to access on a mobile device
- a mobile device reduced the need to carry books
- a mobile device helps the environment by reducing the use of paper
- ebooks assist students with reading difficulties to manipulate the text to meet individual learning needs
- PDAs empowered students to create their own educational content and record their own learning outcomes
- increased mobility provided access dynamic learning opportunities and better resources and beyond the classroom.

CONCLUSIONS

Overall, the film festival framework provided the opportunity to push the boundaries and explore how youth engage with mobile technology and also how the technology supported the needs of the learner by enabling them and the teacher to share educational content in a constructive manner.

With mobile learning it is possible to engage students in activities and assessments outside the classroom. This is an effective strategy for encouraging students to interact with facilities that exist beyond the bounds of the educational environment and engage in real-life activities. In this regard the student is mobile and the device becomes a means for supporting the student in the learning process, this is achieved through establishing supportive communication links.

The framework operates on two levels, the hands-on approach encouraged them to gain expertise with the technology and at the same time they developed conceptual and visual literacy skills. To produce the content they learnt the conventions that underpin narrative structure in storytelling, acquired cinematic language and gained filmmaking skills and knowledge. They learnt by stealth in a program that makes learning fun.

The students actively engaged with the project, most of the students produced their own film and contributed to the production of other class member's films as actors or technical personnel. The festival stimulated interest from other educational institutes, films were entered from Victoria, Tasmania and Queensland. Despite some of the technical problems of hosting the festival on the iHubs the festival was a success. Since the festival the iHubs have been used to host film excerpts as a marketing campaign by some of the major cinema chains. The winning entry was announced at the MLearn Conference in Melbourne where the students presented and overview of their project.

This evidence and the responses recorded to the questions in the Youth Engagement film supported the case that mobile learning encourages reluctant learners by actively supporting them to experience positive learning outcomes. The students were more focused during class activities, their self esteem developed with one male student commenting that he 'felt valued' as a result of being give a PDA to use. Mobile devices are familiar tools for this age group and by providing access to this technology the students gained greater confidence, it increased motivation and this improved the retention rate with 95% of the students successfully completing the program of study.

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Obstacles and Challenges Encountered in South African Secondary School Mobile Learning Environments

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ABSTRACT
Many studies on mobile learning have been lead by European and American researchers and companies and these have identified a number of obstacles and challenges to mobile learning. South Africa has only recently climbed onto the mobile learning bandwagon. Innovators such as South African private schools and mobile learning application development companies are breaking barriers and leading the way for mobile learning to become an integral part of South African education. However, the attitude of parents and educators towards mobile technology, specifically mobile phones in classrooms, seems a very important obstacle towards the implementation of mobile learning in South African school environments. This paper identifies a number of obstacles and challenges (including social and technical challenges) to mobile learning encountered on a global scale as well as in South Africa. This paper also analyses and relates the identified obstacles and challenges with the use of a technology diffusion model.

Author Keywords
Mobile learning, social challenges, diffusion, acceptance

BACKGROUND
The South African educational landscape faces quite a few educational challenges: apart from the poor education that was provided to the majority of South Africans in the apartheid era and the backlog educators still have to deal with, educators also needed to implement the OBE (Outcomes Based Education) paradigm from 1997 as well as extensive curriculum changes that were first introduced in the National Curriculum Standard (NCS) and its revision (RNCS) which is still phased in. Not all teachers are adequately trained and many schools (especially in the rural areas) lack the necessary infrastructure for the provision of computers and internet access. Because of cost, personal computers are just not as common as in developed countries. Also, because of the high cost of telecommunication services and the low bandwidth through which most people get access to the Internet, the majority of the South African school children are still computer and Internet illiterate (Matthee & Liebenberg, 2007: 156).

However, mobile phones are used by a large percentage of South Africans irrespective of race, age, income group or gender. One can mention the MXIT phenomenon by way of illustration: already close to 4 million South Africans (mostly teenagers) are using MXIT, a Java application, extensively (Wikipedia and www.MXIT.co.za). MXIT, which runs on GPRS/3G mobile phones, provides the means to send instant messages at a much lower cost than traditional SMS messaging. Messages are sent and received via the Internet which implies that the cost of the messages depends only on the amount of data sent. The ease with which South Africans adopt mobile technology suggests a wide range of possibilities for development using mobile technology, including mobile learning (Matthee & Liebenberg, 2007: 156).

A number of projects are currently being carried out to determine the viability of using mobile phones as part of the classroom experience. One such a project has been initiated at a private secondary school, Cornwall Hill College. This project is discussed in more detail later. Another project is Dr Math on MXit (Verster, 2007). Dr Math is a support system for secondary school learners. This service provides tutors for mathematics learners between 14:00 and 16:00 in the afternoons after school. Learners send a text message on MXit, describing what difficulties they are having with a specific aspect of mathematics. In return a tutor helps them with their questions.

Attitudes Towards Mobile Technologies in South African Classrooms
The attitude towards mobile technologies in South African classrooms is largely very negative. This fact is corroborated by the number of negative media reports recently. Nicholson (2007) reports that many schools in South Africa decided to lock mobile phones away. She goes on to explain that both educators as well as parents believe that mobile phones and the MXit chat-room trend are sidetracking education in classrooms.

Currently a national policy on mobile phone usage at schools is non-existent. Educators have employed many approaches to try to ensure that school grounds and classrooms stay mobile-phone-free. One such an approach is a mobile phone locker system introduced by Security Cell-Lock whereby lockers are provided for the safekeeping of learners' mobile phones (Nicholson, 2007). This also ensures that mobile phones are kept out of classrooms. Nicholson (2007) also reports that Keith Richardson, headmaster of Wynberg Boys' High, said that they had always found mobile phones to be troublesome, but that the MXit phenomenon had incensed it. Richard was quoted by Nicholson (2007) saying that "(i)t has become out of control, because they look at the teachers but they are using their phones in their pockets. That's how proficient they have become." Even with the risk of having one's mobile phone confiscated for two weeks, learners still take their mobile phones to school. The Cell-Lock system will be implemented at Richardson's school this year. Barnes (2007) also reports that many parents have to lock their children's mobile phones away, as their children would be MXiting (chatting in MXit chat-rooms) instead of studying for their exams.

Another concern of parents and educators is safety. Many parents, as well as educators, are not in favour of learners taking mobile phones to school, as they could then be targeted for their mobile phones outside the school by criminals (Nicholson, 2007; Hawker, Keating & Van der Fort, 2006). Barnes (2007) also reports on the concern for children's safety, as a lot of people misuse chat-rooms to try to lure children into unwanted (and often dangerous) situations. This concern has escalated after multiple reports of children (both girls and boys) being contacted on MXit by older persons pretending to be their peers, and later on arranging secret face-to-face meetings with the child (Peters, 2006; Rondganger, 2006).

However, not everyone sees mobile phones in the hand of learners as all bad. Nicholson (2007) quotes the Gauteng provincial Education MEC, Cameron Dugmore, saying: "Personally, I don't think cellphones should be banned from school premises, but should be banned from being in the classrooms." The MEC suggested that school governing bodies take on a "workable guideline" with regards to mobile phone usage at schools. At another occasion Barnes (2007) also quotes Gert Witbooi, spokesperson of the provincial Education MEC, saying that "new technology is good" and that although the provincial government supports the initiation of new technologies into education, parents have to control and manage their children's actions on mobile technologies.

Creators of the MXit chat-room application, which has been the cause of many parents' and educators' frustration, have also decided to utilize their technology in order to advance education and to try to counter all the controversy surrounding their product. Barnes (2007) reports that MXit plans to launch a countrywide educational campaign. According to Barnes (2007) the CEO of MXit, Herman Heunis, plans that the main focus of the MXit educational campaign will be that of educating teachers and parents. Educators and parents, as well as different supporting bodies, will be involved in the campaign to discuss concerns about user security in chat-rooms. Being aware of such concerns MXit has implemented dynamic chat-rooms "to be private and safe" (MXit, 2007). MXit's dynamic chat-rooms allow one to create one's own private chat-room, where participants have to be specifically invited to be able to join. These private chat-rooms are also password-protected and the creator of such a private chat-room has moderating rights.

RESEARCH PROBLEM

From the above discussion it is clear that although mobile learning holds a lot of promise for addressing some of the education problems in South Africa, the implementation of it faces quite a few challenges of which social ones such as attitudes, perceptions and lack of knowledge may be the most important. This paper aims to investigate this statement but also to identify other major obstacles and challenges encountered in South African secondary school mobile learning environments.

METHOD

It was decided that the interpretive approach would be best suited to investigate this matter. Interpretivism as an underlying research philosophy does not prove or disprove a hypothesis, but is concerned with "understanding the social context of an information system" (Oates, 2006: 292). Educating learners occurs much more in a social context than it does in a measured and a controlled environment. Also, although challenges and obstacles (to mobile learning) include technical aspects, it also involves cultural and social issues which will be better understood if one can find the meanings that people assign to it.

Semi-structured interviews were used as a strategy and data collection method. Documents were also used to get a clearer understanding of the context of the interviewees. It was decided to use interviews since it allowed the researcher to ask complex questions and explore research subjects' experiences with and feelings towards m-learning. Through interviews the researchers could also acquire more comprehensive information. Because a qualitative approach complies better with interpretative research than a quantitative approach does, it was decided to follow a qualitative approach to analyse research data generated by the interviews. To qualitatively analyse the interview data, the data was first prepared. This was done by transcribing audio tapes containing the interview data. A hybrid technology diffusion model (which is explained later in this paper) was used in the analysis of the data by identifying and relating key themes. The diffusion model was therefore used as the underlying theory to help with the interpretation of the interview results. It also helps in understanding the intricacies of acceptance of this technology in learning environments.

The interviewees came from two settings. The first group of research subjects consisted of learners and an educator of a private secondary school in South Africa. This group was interviewed to determine which obstacles and challenges both learners and educators have encountered with m-learning. A one-on-one interview was conducted with the educator and a group interview with six learners.

The other setting involved a private South African company which develops m-learning applications. The CEO of such a company was also interviewed. This one-on-one interview was conducted mainly to determine technological obstacles and challenges that developers in his company have encountered while developing and implementing an m-learning application.

Both settings will now be explored in more detail after which the hybrid technology diffusion model that was used for the data analysis will be explained.

Case 1 – Cornwall Hill College

Cornwall Hill College has been experimenting with mobile learning for a while now. They have utilised mobile phones in education in mainly two ways (discussed below).

The first is a very informal use of mobile phones in a classroom environment. This is where learners are allowed to use their mobile phones to take pictures, make videos or take notes in class. These notes, pictures and videos thus serve as a means of revision. In some classes learners are also allowed to use their mobile phones to access the Internet, should they require extra information to complete an in-class assignment.

Second, Cornwall Hill College worked with the Meraka Institute of the Council for Scientific and Industrial Research (CSIR) in South Africa on a project called MobilED. They also partnered with Media Lab of the University of Art and Design Helsinki (UIAH) in Finland. A pilot project was launched in March 2006 at Cornwall Hill College in Pretoria, South Africa, namely an HIV/AIDS project aimed at grade 11 learners. The project ran over three weeks, included five lessons and was designed to generate HIV/AIDS related discussion topics (Botha, Batchelor & Leinonen, 2006).

Learners were divided into audio-casting groups and thematic expert groups. Thematic expert groups had to gather information about a provided topic (related to HIV/AIDS), using the MobilED tools. MobilED tools consisted of a MobilED KIT, the MobilED Wikipedia service, pens and notebooks as well as study guides (Botha, Batchelor & Leinonen, 2006). A MobilED KIT is a box containing mobile tools, software as well as a manual that can be used in a classroom to enable collaborative mobile learning projects (MobilED). Learners in thematic expert groups were able to contact Wikipedia by means of sending a keyword term to the server, after which the server would “call the learner’s mobile phone, and a speech synthesizer would read the article to the learner” (Botha, 2006: 5). The gathered information was then discussed within the group to decide on the findings that will be presented to the audio-casting group.

Findings from the thematic expert groups were passed on to the audio-casting group and then debated there again. Learners in the audio-casting group now had to decide which content to include in the audio-casting, after which the audio-casting group designed an audio-casting show by writing a script for the audio-casting and producing it. The audio-casting show was a small radio-play of two to four minutes which was then communicated to the whole school community (Botha, Batchelor & Leinonen, 2006).

Summary of interview results

The main thrust of the interviews is given here. An interpretation of these and other results of the interviews will be given later in the paper.

The interview with the educator revealed several technological obstacles including small screens, low screen resolutions and limited storage space. The educator believes that mobile learning can be beneficial in the sense that “they use more senses than just the educator bringing information across…” by recording, video-taping or typing memo’s in class (“they use it to store information until they can formally put it down”). She also mentioned the problem with phones being a status symbol (which relates to peer acceptance) and a security threat: “children are often more aware of somebody having something bigger and better than them …” and cell-phones are “your prime target of theft in any school” and “parents often give their child the cheapest phone going around” so they “end up with phone that don’t have the facilities”. She believes that implementing mobile learning will lead to a paradigm shift “which would be the paradigm shift of the educator … because I think for a lot of educators its not that easy to let go of their freedom, because you’re not that much in control”. The educator believes that there is a place for both mobile learning and traditional teaching in the classroom: “I think if a person just works on the video and that type of thing, that’s when you actually start taking the child’s involvement away “…” you’ve taken away his ability to communicate and verbalise”. (Transcripts of interviews available from authors).

The interview with the learners confirmed the technological obstacles mentioned by the educator but mentioned bandwidth specifically as the biggest problem. Their understanding of mobile learning is limited to their experience: mobile learning is to “use your phone in the classroom”; “using” the phone” to spread information”. They find mobile learning beneficial in the sense that it is a way of note taking: “the other day I couldn’t record pictures on the dissection that we were doing. And XX took pictures on her phone, and she could just Bluetooth them to me.” In general students felt that educators are not ready to implement mobile learning: “some teachers, if they see your phone, they’ll will take it away”; “they are old-fashioned”; “they are not even open to the concept”. They also find that their parents are often opposed to them using their phones – this relates mostly to the use of MXIT: "I think that our parents think that we spend too much time on MXIT" (all students agreed with this statement).; "once our parents hear that whole story they get suspicious" (referring to activities of pedophiles on MXIT). The learners also believe that mobile learning only make sense when it is directly linked to their school work (Transcripts of interviews available from authors).

Case 2 – The MOBI Project

In short, MOBI™ is a mobile edutainment (education and entertainment) application providing learners with anytime, anywhere learning on most mobile phones that are Java-enabled. MOBI™ was developed by the South African secondary school ICT education company - IT School Innovation (ITSI) - and went "live" on 17 July 2007. MOBI™ is currently a mathematical mobile phone application. The product is curriculum based and aimed at secondary school mathematics learners (grade 8 to 12). Through MOBI™ learners are able to view a number of tutorials, examples, exercises and previous matric exam papers via streamed videos. MOBI™, in addition, provides learners with an assessment function which can help a learner establish his/her skills in a variety of mathematical concepts.

To have full access to all MOBI™ content, a learner has to pay a monthly subscription fee of R30. MOBI™ does not charge any additional fees for viewing or downloading tutorial videos, however such downloads or viewings are still subject to the cost of data as determined by the downloader's service provider.

Summary of interview results

The interview dealt mainly with issues around the technology needed to design and implement mobile learning solutions. The interviewee mentioned the difficulties with J2ME "which every phone model implement differently". Also the fact that "3G is not available everywhere and that not all phones have 3G capabilities". The videos are in 3gp format which again is interpreted differently by different phones. On a question regarding acceptance and attitudes by teachers and parents, the interviewee had the following opinion: "the world is more complicated than when the adults grew up. Obviously the parents try to protect their children and the teachers try to protect their authority but we live in the world of Web2". (translated from Afrikaans, transcripts available from authors).

A Hybrid Technology Diffusion Model

The authors compiled a hybrid technology diffusion model from the Technology Acceptance Model (TAM) suggested by Davis (Davis, Bagozzi & Warshaw, 1989: 985), the Innovation Diffusion Theory (IDT) first proposed by Rogers (2003), ideas of Wu and Wang as cited by Chang and Tung (2007:73), Chang and Tung (2007:77) and Fichman (1992). This model was used to analyse and relate the obstacles and challenges to mobile learning identified in literature and in the interviews. Also, the authors have decided to use this hybrid diffusion model instead of only a single diffusion model or theory, because they believe that such a hybrid diffusion model is able to address a more complete spectrum of mobile learning obstacles and challenges including the social, individual and cultural aspects.

The model is given in figure 1 and will be explained below:

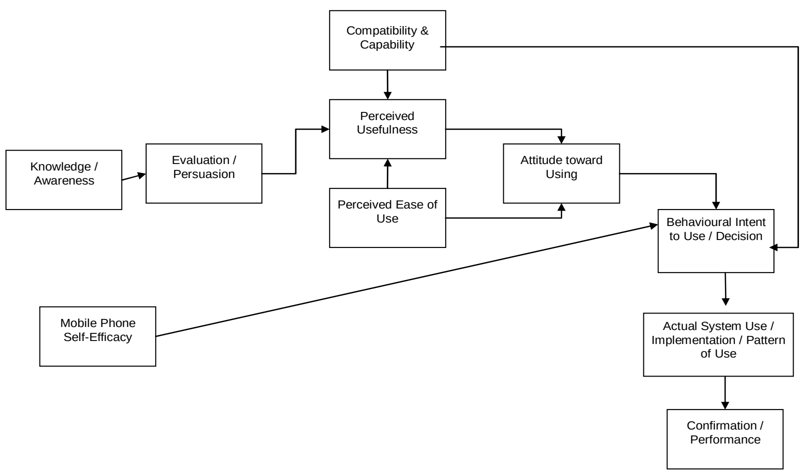

Figure 1: A Hybrid technology diffusion model

This hybrid diffusion model (figure 1) indicates that *knowledge or awareness* of mobile learning (actually becoming aware of the existence and purpose of the innovation) directly influences the evaluation or persuasion stage of IT diffusion, i.e. one cannot evaluate something if one is not aware of it. Also, if one lacks knowledge of such an innovation, one will not be able to adequately evaluate it or fully comprehend its significance.

The *evaluation or persuasion stage* (becoming persuaded of the significance and value of the innovation) affects the user's perceived usefulness of the innovation. Perceived ease of use and the user's compatibility with the innovation and capability to use the innovation also affect perceived ease of use. *Perceived usefulness* as well as perceived ease of use influences the user's attitude towards using the innovation. If a user does not see an innovation to be useful and/or easy to use, his/her attitude toward using the new innovation will mostly be negative. Just so, if a user sees an innovation as useful and easy to use he/she will have a positive attitude towards using it.

In *the behavioural intention* to use or decision stage, a person decides whether or not he/she will adopt or embrace the innovation. This stage is influenced by the person's attitude towards using the innovation, his/her compatibility with the innovation as well as his/her capability to use the innovation, and his/her mobile phone self-efficacy (a user's perception of his/her proficiency or ability in using a mobile phone to complete a task, instead of mimicking effortless component skills). Once a person has made a decision about adopting or embracing an innovation it will affect the actual use of the innovation or the implementation thereof. For example, if a person has decided to not fully embrace the innovation, he/she will use the innovation half-heartedly.

Only once the innovation has actually been used or implemented, can it be finally accepted or rejected, or can its effect on performance be measured. This occurs in the *confirmation or performance* stage. The actual use or *implementation* of the innovation thus affects the performance or confirmation (accepting or rejecting) of the innovation.

FINDINGS

In this section findings from literature as well as the interview results from both cases are interpreted at the hand of the hybrid diffusion model (figure 1).

Knowledge/awareness

From both cases' interviews it is apparent that awareness is an immense challenge experienced in the mobile learning environment. Neither learners nor the educator interviewed were aware of the existence of other mobile learning applications (such as MOBI™). Also, the learners interviewed could not form a complete idea of what mobile learning entails. They only saw mobile learning as using a mobile phone in a classroom environment. Because they were unaware of any mobile learning applications, they did not see the "learning any time, anywhere" notion as part of the mobile learning definition.

Parental acceptance and teacher acceptance of mobile learning and mobile learning applications are other obstacles that can be directly linked to the knowledge or awareness stage. From both case studies it is clear that parents and teachers do not accept such technologies because they are uninformed. Parents' and teachers' opinions are influenced mainly by negative publicity (Mifsud, 2002), instead of adequate knowledge of the technology. Learners interviewed suggested that teachers should be shown how to use mobile technologies, so that they will be more open to the idea of using it in a classroom environment.

Evaluation/persuasion

The challenges of mobile learning and mobile learning applications awareness, as well as parent and teacher acceptance thereof also influence the *evaluation or persuasion stage*. In this stage one becomes persuaded of the significance and value of mobile learning or the mobile learning application. However, if one is not aware of mobile learning applications one cannot see its significance. Also, if one is uninformed about or does not dispose of adequate knowledge about mobile learning, one might not become persuaded to use it or see its significance.

Perceived usefulness

This in turn affects one's perception of the usefulness (the degree to which it will help one perform a task) of mobile learning or a mobile learning application. In the interviews the educator as well as the learners indicated that they perceive mobile learning as useful if it provides them with high quality pictures and/or videos, if its connection is stable, if it doesn't require too much storage space or it provides additional storage space (for example the ability to store information on a remote server), and if they are able to share information (with, for example, the use of a chat-room). They also indicated that they perceive mobile learning in a classroom environment to be useful when they can take pictures and videos, and when they can have fast access to the Internet. The interviewee in the first case also indicated that bandwidth is an obstacle, and that screen size had to be taken into consideration in the development of a mobile learning application. The interviews thus concur quite a number of obstacles identified from research studies that has an effect on one's perceived usefulness of mobile learning. These include: inadequate picture/video quality (due to the low screen resolution and small screen size of mobile phones); low bandwidth; limited storage space; limited battery life; and connection stability (Papanikolaou & Mavromoustakos, 2006; Holzinger, Nischelwitzer & Meisenberger, 2005; Shudong & Higgins, 2005).

The fact that learners have indicated that their perception of mobile learning's usefulness is influenced by the availability of quality video, also supports the statement of the CEO of IT School Innovation. This interviewee indicated that converting videos into a 3gp-format which can be read by most mobile phones proved very challenging. Such a technical challenge will thus indirectly affect perceived usefulness, as it influences the availability of quality video on a mobile

Also, the obstacle of limited security identified in the literature review (but not confirmed in the interviews) can influence perceived usefulness, as an mobile learning application with security risks can be seen as unsafe instead of useful (He, He and Rogers, 2005).

Compatibility and capability/ Perceived usefulness/Perceived ease of use

The hybrid diffusion model indicates that compatibility and capability have an influence on perceived usefulness. Compatibility is "the degree to which the innovation is perceived to be consistent with the potential user's existing values, previous experiences, and needs" (Chang & Tung, 2007: 73) and capability refers to one's ability to use the technology. Educator readiness, an obstacle identified in all the interviews and confirmed by literature (Mfisud, 2005), has to do with educators not knowing how to use mobile learning technologies. Educators' age and familiarity with mobile learning technologies often influence how compatible they will initially be with mobile learning or mobile learning applications. An educator's previous experience with technologies that are incorporated in mobile learning (such as mobile phone and computing technologies) and with technologies that are similar to mobile learning, also have an effect on how capable they are in using mobile learning or an mobile learning application. As indicated by all the interviews, learners are ready for mobile learning. They are far more compatible with and capable of utilising mobile learning, because they have been using the supporting technology (mobile phones) from a young age and they are using it constantly on a day to day basis (they are very familiar with mobile learning technologies).

All parties interviewed also mentioned another possible obstacle to mobile learning – a course-design to facilitate chunking – that can influence compatibility and capability. If mobile learning content isn't presented in reasonable, meaningful amounts, and if it isn't linked to a learner's curriculum, it will not satisfy a learner's learning needs or an educator's teaching needs. Thus mobile learning or a mobile learning application will not be compatible with the learners, the educators and their learning/teaching environment.

Many aspects of compatibility and capability influence perceived usefulness, while others influence behavioural intention to use. Some can influence both perceived usefulness as well as behavioural intention to use. However, aspects that are more concerned with capability than with compatibility tend to influence behavioural intention to use, rather than perceived usefulness. Obstacles and challenges related to capability are discussed later on in this section.

The hybrid diffusion model also indicates that perceived usefulness is influenced by one's perception of how easy mobile learning or a mobile learning application is to use. The educator and learners interviewed explained that they would find mobile learning or a mobile learning application easy to use if it can be used quickly. They elaborated, explaining that input has to be quick and easy, it shouldn't be memory intensive (meaning applications work effortlessly without freezing) and one should be able to easily read pictures and text from the screen. One can see that the interviewed educator's and learners' perceptions of ease of use and usefulness are very closely related. However, all interviews still gave rise to a number of obstacles that might affect perceived ease of use, and thus in turn affect perceived usefulness.

An obstacle identified in the literature (Brigland & Blanchard, 2005), as well as in the interview with the educator is that of educator support. A lack of sufficient educator support (showing educators how to utilise mobile learning technologies, etc.) can affect how easy to use an educator perceives mobile learning or mobile learning applications to be.

A number of obstacles and challenges to mobile learning, which are concerned with compatibility and capability, have been identified in the interviews. From the interview with the educator it became clear that many teachers and learners (especially in rural areas) grew up without electricity and most technologies (such as a telephone or a computer). Consequently, they do not have any previous frame of reference which they can use to explain the workings of a mobile phone to themselves. No matter how willing they are to adopt the technology, they simply might not be able to do so as easily or as quickly as others can, because they do not possess of the ability to do so. Therefore, the obstacle identified in the interview – lack of adequate frame of reference – is related to one's capability to use mobile learning.

Another obstacle identified in all the interviews is that of cost. The cost of mobile learning in South Africa is still not inexpensive and thus not accessible to all. This obstacle relates to compatibility and capability which affects one's behavioural intention to use. Even though one is aware of the high costs of mobile learning, it can still appear to be easy to use or useful. However, the cost involved in mobile learning can render one incapable of using mobile learning, because one cannot afford it. This in turn affects one's decision on whether to use mobile learning, or not.

Peer-acceptance is also a possible obstacle identified in the interviews. The educator interviewed explained that when mobile phones are used in a classroom environment, learners are very aware of other learners having a newer or better mobile phone than themselves. Those learners with "bigger, better" mobile phones also like showing them off, often resulting in a feeling of inferiority from learners with older, less impressive models Learners feeling inferior often do not want to participate in classroom activities involving their mobile phones, as they feel, in a sense, embarrassed to use their mobile phones. Peer-acceptance does not have an influence on whether one perceives mobile learning application to be useful. However, compatibility is concerned, amongst others, with one's current needs. For a learner peer-acceptance is a current need. One can thus infer that peer-acceptance relates to compatibility and capability. This obstacle to mobile learning will therefore have an influence on one's behavioural intention to use or one's decision to adopt mobile learning.

Behavioural intention

All the obstacles related to behavioural intention to use or adopting mobile learning, will in turn affect the actual use of a mobile learning application. For example, if the cost of mobile learning is too high, and the person decided not to use mobile learning, or to use it only occasionally, it will affect to which extent mobile learning or the mobile learning application will actually be used or implemented, if it is used or implemented at all.

Actual system use and performance/confirmation

The extent to which mobile learning is used or implemented, affects the performance thereof and thus whether mobile learning is finally accepted or rejected. Therefore, all mobile learning obstacles and challenges have, in essence, an effect on whether mobile learning is accepted or rejected and how it is diffused.

CONTRIBUTION

The above discussion suggests that given the South African educational challenges as well as the ease with which the South Africans have adopted mobile technologies, there exists a wide range of possibilities for using mobile learning to enhance current education initiatives. The school that was used in one of the cases is a private school implying more availability of funds and other resources. Some of the interviewees from this school were also involved in a similar pilot at the Irene Middle School (a government school). Based on their experiences there, they believe that the incorporation of mobile learning into government schools in South Africa is very viable. From the interviews it was established that government schools can expect to encounter the same obstacles and issues as private schools have encountered with the implementation of mobile learning. Government schools are often much larger than private schools and they frequently accommodate a very diverse part of the population. Some government schools cater for the wealthy, others cater for the less privileged, and some for both. In many rural schools educators, as well as learners, grew up with no electricity and thus mostly no technology (such as computers) either. The educator interviewed believes that this will not have an influence on the type of obstacles encountered, but only on the time it will take and the degree of difficulty with which mobile learning will be implemented. However, being aware of the obstacles and challenges of mobile learning could help educators and decision makers to design more efficient and effective mobile technology enhanced learning environments for government schools. It could also serve as a guide for private investors and NGOs who are interested in investing time and money in mobile learning initiatives.

EVALUATION

This research study is based on a research project conducted by a fourth year student in Information Systems under the supervision of the second author. The student had to complete the project within six months. Because of the limited time and because of the difficulty of getting permission to conduct research in government schools, the interviewees were from a private school. It was also difficult to get access to other private schools where mobile learning initiatives were taking place which limited the number of interviewees. This limits the contribution of the findings from this study to the greater South African educational landscape. Although interpretive research does not make the same claims towards generalisability as positivist research, the choice of interviewees should still support the argument. This is done only in a limited way since the situation in private schools in South Africa is often very different from the average government school (which serves the majority of pupils). However, this specific private school was also involved in a joint mobile learning project with their neighbour government school and the authors believe the interviewees provided some valuable insights from this experience.

CONCLUSION

In conclusion, many "global" obstacles and challenges to mobile learning have been identified. Several of these obstacles and challenges as well as an additional few, are present both in South African private schools and in companies developing mobile learning applications – the biggest being acceptance. These obstacles, however, have not prevented some South African schools and development companies to experiment with mobile learning. Although the identified obstacles and challenges are very real, over time it is sure to diminish – as is the case with any new technology. And thus, the researchers feel confident to say that mobile learning will not disappear, but will gradually become more ubiquitous in our daily lives, just as the case has been with computers and the Internet.

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The MOBO City: A Mobile Game Package for Technical Language Learning

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ABSTRACT

In this research we produced a mobile language learning game that is designed within a technical context. After conceptual analysis of the subject matter i.e. computer's motherboard, the game was designed. The action within the game is consistent to the theme. There is a story, simplifying and exaggerating real life. Elements of control, feedback and sense of danger are incorporated into our game. By producing an engaging learning experience, vocabularies were learned incidentally. Deliberate vocabulary learning games were also added to our package to help students solve their common errors.

Keywords

Mobile learning, Educational games, Language learning, Vocabulary learning

INTRODUCTION

Mobile learning offers the potential for radical change, not only in learning itself (Eschenbrenner and Nah, 2007), but also in relation to the digital enfranchisement of previously-excluded populations in the developing world. In Iran, as a typical developing world country, there is massive pressure for educational development, in order to underpin industrial and economic development. The penetration of cabled access is low, reaching only a modest proportion of the population. Ownership of personal computers is also very limited, economic factors being compounded by problems of unreliable electricity supplies. On the other hand, access through the mobile phone system has the potential to be far more propitious, since the terminal hardware is far cheaper than a PC, has a more reliable power supply, avoids cabled connections, is already very widely deployed and has the great virtue of familiarity to a substantial proportion of the target audience. Following a study of opportunities for mobile learning in Iran it was recognized that most students in urban areas possess mobile phones and the only mode of communication available for rural students is that of mobile phones (Fotouhi et al, 2008). In the survey it was obvious that mobile phones are facilitating access to information amongst Iranian students. However, it is still not recognized as a training tool. In this paper we examine possibilities of using mobile games in language learning classes. Thorton and Houser (2005) and Levy and Kennedy (2005) developed several innovative projects using mobile phones to teach English by SMS. Unfortunately, problems with SMS teaching include its limited features and lack of students' engagement. It is not possible to keep students motivated. According to Fotouhi et al (2008) 89% of students had WAP 2 enabled mobile phone and the use of Java mobile games is growing in Iran. Using games that increase students' interest and simultaneously increasing their amount of practice of language is very appealing. Game-based learning can be viewed as a particular form of incidental learning where the learner is engaged in an activity that may not be directly tied to the task at hand. A detailed analysis of game playing and digital games for education has been provided in (Prensky, 2001; Sale and Zimmerman, 2003). Game-based learning has being proposed for Higher Education to motivate assignments, curricula, and undergraduate research (Morris and Jackson, 2007; Clua et al., 2006). A number of games, however, have been proposed and used for teaching English as a second language (EslFlow, 2006). Mobile language learning games have been also designed, for example crossword game (Hung & Youngs, 2007). The research in this paper revolves around a Language Learning project using game for Iranian University students. The authors demonstrate that it can facilitate students' learning motivation and engagement in the interactive learning environment.

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THEORY

Modern linguistic theories of and instructions for second language acquisition emphasize greatly on the use of language for *meaningful* communication (Littlewood, 1981). They argue, students can usefully be taught some non-language related subjects, such as history or computing, in a second language. The assumption is that the learners *would* acquire the second language simply by using it to learn the subject matter content, without the second language being the focus of explicit instruction. In this research we produced a scheme that pursues this line of theory. To teach technical English vocabulary to students, we chose to teach a technical subject (motherboard components), and we introduced necessary vocabulary indirectly during our instruction. Concept maps were used as a kind of *template* or *scaffold* to help us to organize computing knowledge. As a result the subject was divided into small units of interacting concept and propositional frameworks. This follows from Novak, who believes concept maps facilitate meaningful learning and the creation of powerful knowledge frameworks (Novak and Wandersee, 1991). It seems evident from diverse sources of research that our brain works to organize knowledge in hierarchical frameworks and that learning approaches that facilitate this process significantly enhance the learning capability of all learners (Bransford *et al.*, 1999; Tsien, 2007).

Obviously, our brains store more than concepts and propositions. While the latter are the principal elements that make up our knowledge structures and form our cognitive structure in the brain, other forms of learning exist such as *iconic learning.* This involves the storage of images of scenes we encounter, people we meet, photos, and a host of other images. These are also referred to as *iconic* memories (Sperling, 1963). While the alphanumeric images Sperling used in his studies were quickly forgotten, other kinds of images are retained for much longer periods. Our brains have a remarkable capacity for acquiring and retaining visual images of people or places, but soon forget the details (Shepard, 1967). To teach about computing, we integrated various kinds of images into our concept maps. The idea was to enhance iconic memory via conceptual frameworking. Therefore we used both visual and verbal mental imagery to relate a word to be memorized. By this stage the context is created in an organized structure but what is missing is the motivation of our students to use our materials. Most m-learning content tends to consist of summarized PowerPoint files, PDFs, WAP sites "gussied up" with graphics, photos and in advanced cases, videos. Providing some verbal or visual material to students without keeping them immersed and interested in context is not as useful as it could be. If we make the educational content more interesting, we can make it more effective. At its best, learning should be a wildly enjoyable experience. There should be joyous discoveries, satisfied completions and sudden recognitions. We need to address the emotional side of learning as well as the knowledge side. The other important factor in instruction is the "normal flow of learning". Several researchers defined flow as "*the state in which we are so involved in something that nothing else matters*" (Csikszentmihalyi, 1990). Cleverly designed educational games can provide such a flow for an individual learner and keep them simulated throughout instruction. Interaction is another important aspect of educational games, which is proposed in game learning theories and models (Amory and Seagram, 2003; Barendregt and Bekker, 2004; Said, 2004). The learner's interaction with game is essential as it defines how could the learners control the game and learn from it. The interaction element adopted in our game uses the Interaction Cycle suggested by Barendregt and Bekker where the interaction between a user and a computer game happens in terms of cognitive and physical user actions. (Barendgret and Bekker, 2004). At the first stage, learners understand the rules and goals of each task in the game then they decide the actions to be taken to accomplish the task. After taking appropriate actions to complete the task, the game provides feedback to learners. Based on the feedback, learners evaluate whether the task is completed successfully or not. This is useful in deciding whether the learners have conceived the correct information. Learners will then repeat the interaction cycle on the same task or proceed to the next task. Motivation here is a key aspect for effective learning and is sustained through feedback responses, reflection and active involvement in order for designed learning to take place. Other factors that has an impact upon learners' motivation in educational games relates to sense of challenge, game realism, opportunities to explore or discover new information. According to the researchers these motivational variables should be considered in game development and use (Malone 1981; Rieber, 1996; Thomas and Macredie, 1994; Amory, 2003). These elements could greatly facilitate the learning process and has been incorporated in our game.

METHOD

Our mobile game was designed to teach technical English to Iranian students in the University of Qom. The package was produced as a platform-independent application. The chosen development environment was Java 2 MicroEdition (J2ME). After organizing the sources about motherboard components into concept maps, their corresponding environments and characters were designed and then the necessary vocabulary was inserted inside the game as a kind of verbal feedback and guide throughout the game.

MOBO city stands for Motherboard City because the game's main theme is that of a motherboard. The metaphor is of a city where at different locations, electronic components are located, just like in a real motherboard. The complex task for the motherboard is to move data in the right order and right manner, to the right recipient. Our main characters are a red bus and its driver (Figure 1 and Figure 3). The bus represents a 'motherboard bus' whose its duty is to transfer information across the relevant components. The bus driver's name is OS which is abbreviation for operating system.

An operating system manages hardware and guides the flow of data; hence what drives and directs the bus of data is called OS. In the game the OS will do the paper work for data bus passengers in each station (Figure 3 and Figure 4).

Our game is an adventure where the player assumes the role of a character within a world of fantasy (Mobo City). The player can control his character and thereby cause the character to move about in the fantasy world, investigate and interact with whatever is encountered in the world. The character can, for example carry out dialogues with other characters in the fantasy, for example security men. The story begins when our red bus receives a new task, for example "There is some data just arrived from scanner ship, pick them up from USB port and take them to monitor theatre, where they have to perform a show that has been organized by Viewscan Corporation" which illustrates how scanned data is shown in a monitor, using Viewscan software. There is a clear goal that the player will be trying to achieve, i.e. to successfully send data to its destination, the monitor. This goal will provide a motivation for the action and a metric for attainment. The questions normally asked in the game are related to the computer's common processes, such as accepting input, executing instructions, generating output and displaying or storing results. However it must be in accord with the game story, providing a task for the city bus. The bus has to move data through MOBO City passing through different components in the right order. For each question a flow diagram is produced.

The bus must reach its destination in order for a player to win a game. The game displays pertinent information related to the state of the game such as life points, which is initially 5, and the score, which is initially 0, in the information bar displayed along the top of the game screen (Figure 1 and Figure 2). The game finishes when the player loses all their life points. The game is not static; other characters such as virus ships can move about and act on their own. The bus must be aware of virus ships at all times, because they try to destroy the data bus (Figure 1). If hit, the player looses 1 life point. The game consists of a network of distinct physical *contexts* such as the rooms of an office or bus stations of a city. On the motherboard, next to each main component, there is a bus station or bus stop. A congratulatory message will be shown each time the bus passes through a correct bus stop, the player scores 5 and the bus moves on. Some components have the sign of a station next to them which mean that some tasks which need to be done (Figure 4). If the bus passes through the wrong component a 'you are not allowed!' message will be shown and the player looses 2 points. If the player passes through a component too early, a 'come back later!' message will be shown. Passing through a correct station produces a congratulatory message and the player gains 5 points (Figure 1 and Figure 2).

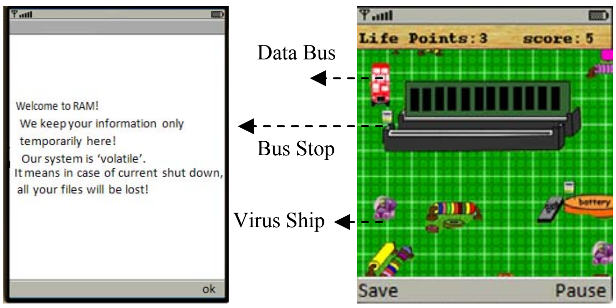

Figure 1. The game shows an appropriate message when the bus arrives at RAM bus stop.

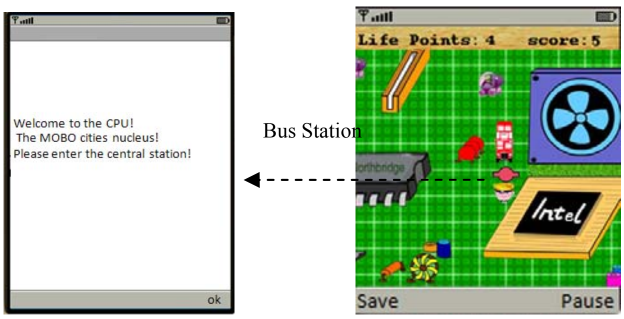

Figure 2. The Game shows an appropriate message when the bus arrives at CPU bus station.

When a message page appears all virus ships will stop. We limited the message pages to a few seconds in order to avoid the players loosing the game flow. In each different bus station, the physical feature such as background and characters are changed according to the kind of work that particular component involves. We made a concept map for each component, questioning: What parts does it consist of and what do they do? The graphic inside each component is produced according to its concept map. The bus driver OS moves inside the component. The component consists of rooms inside which there are different characters, each responsible for different kinds of jobs. The driver has to meet all of them, but in the correct order. The security men in front of each room help the player to get an idea of what job characters in each room are involved in. However, the player is constantly being followed by spy viruses that have escaped from the security men, in front of the station. If he is attacked by one of viruses, the player looses 5 points. Each time the player meets the correct character, he or she scores one point. The environment inside a CPU and the dialogue where the bus driver gets involved with different characters is shown in the figure below:

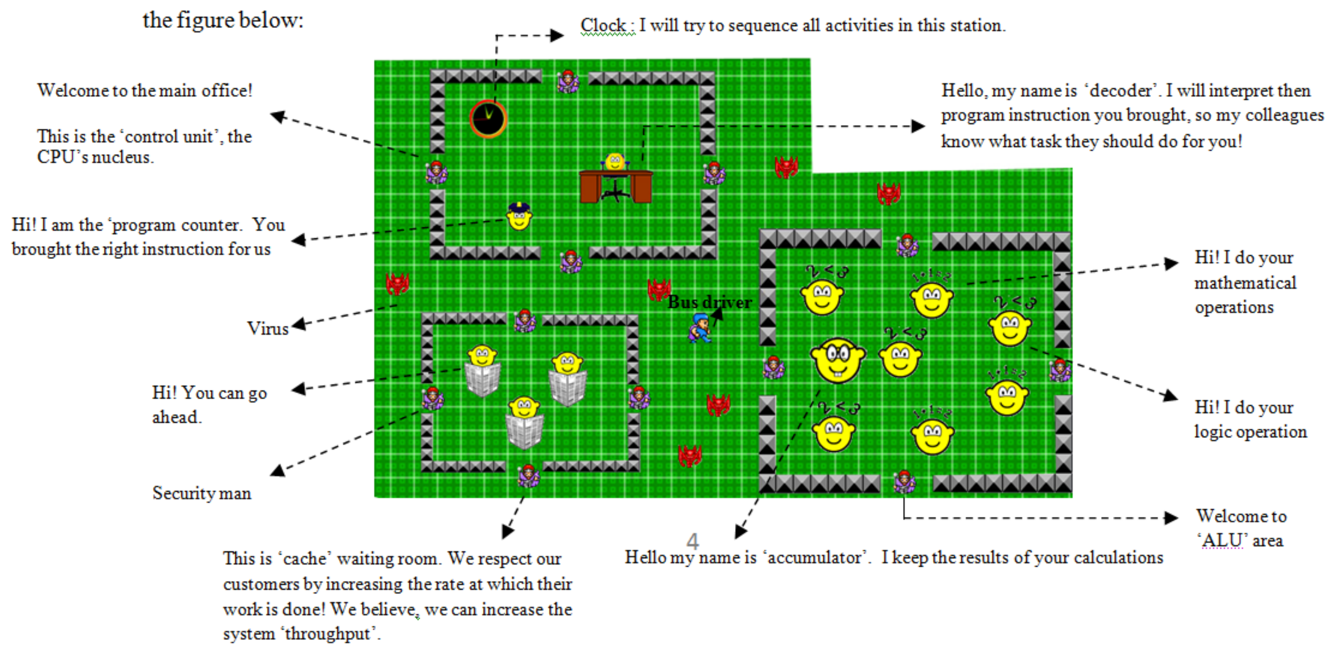

Figure 3. The game background inside the CPU.

You can see the environment inside a Graphic Card, dialogue that OS can get involved with and different characters in the figure below:

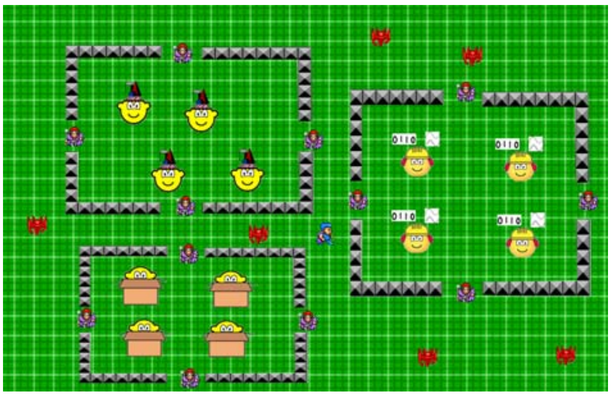

Figure 4. The game background inside Graphic card.

EVALUATION

Technical English course units are very important for computer engineering students because relevant textbooks are mainly written in English. Due to the nature of their field of studies, they have to extensively use the Internet, which is also dominated by English. The role of English in passing MSc and PhD entrance examinations is significant. Despite its importance, it is offered for only one semester during the student's four years of study and its lecture time is very limited, only 2 hours per week. On the other hand there are few lecturers that are both competent in English Linguistics and Computer Engineering. In addition to all this, the students' attitude towards these classes is that of weariness and it has very little appeal for them.

15 students from the third year of computing Engineering whose levels of English were as equal as possible were selected. We divided them into three groups, the first 5 tried to read a comprehension describing motherboard components without using a dictionary. The second 5 were asked to use the dictionary and to memorize a list of vocabularies and the last 5 were asked to play with our MOBO city game (Table 1). Then, a list of vocabularies that all three groups have encountered in their tasks was presented to them and their level of vocabulary understanding together with spelling was examined.

	Group using reading comprehension					Group using dictionary					Group playing games				
Students No.	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Spelling Results	22	28	24	25	25	26	26	25	27	30	26	25	29	23	22
Meaning Results (answers in context)	9	15	16	19	13	30	25	12	20	35	41	35	43	37	31
Meaning Results (answers out of context)	-	-	-	-	-	15	12	10	12	10	-	-	-	-	-

Table 1 . Result of how to spell…? and what does …..mean? from 46 vocabularies.

The results show that students reading skill is very low, using the dictionary does help (Table 1). However it has two main drawbacks; first, it is a tedious job and students are often reluctant on using it; secondly they often only learn the first meaning and consequently it produces out of context learning. For example in this study the word 'nucleus' referred to 'a central part about which other parts are grouped or gathered' but in some dictionaries it is described as 'usually spherical mass of protoplasm encased in a double membrane' in other dictionaries as 'the positively charged mass within an atom' and others as 'a mass of nerve cells in the brain'. This is the result when the vocabulary is taught out of context. Computer students in our evaluation not only had a problem with second language learning, they also lacked some technical concepts of the motherboard and this made understanding the related comprehension very difficult for them. For example they were not familiar with vocabularies such as: AGP , PCI, Bios, expansion slot. MOBO city, by helping them learn the subject matter, helped them greatly in learning technical vocabularies. Below are listed the remarks of students' observations of the game:

"The objective of the game was clear, we knew what was expected from us." A basic rule of instructional design put forward by Gagne in 1965 seems far too commonsense but still, inordinately, relevant today: to inform learners of objectives and goals (Gagne, 1965). These goals need to be presented early (Malone, 1981), need to be clearly stated and should be personally meaningful, obvious and easily generated (Malone 1981).

"The storyline was both fun and educational." Designers need to tune the educational message to the content, in other words, game goals which are fun and learning goals need to be in harmony with one another.

"It felt real, we got feedback for what we did and we should have been ready for dangerous surprises from viruses."
In the real world we can control events and get perceptual feedback concerning what we have done, we must constantly be ready for dangerous surprises. Perhaps, when this sense of vulnerability in usual online learning is absent, our whole experience is sensed as unreal. By means of educational games we can invent virtual worlds that simulate this sense of reality for students.

"The learning experience produced by game was neither too difficult nor too easy!" The degree of difficulty is an important feature in games; for players to enjoy playing, the game must be neither too difficult nor too easy (McFarlane et al 2002).

"When playing the game I lost track of time." What makes game learning so distinctive from other types of learning is its essence of flow, context, control and in brief immersion and engagement in learning, which is difficult to achieve with other types of learning.

"After playing a game I could easily produce its concept maps, the learning really sticks in." On the other hand, when the learners' 'heart and mind' are captured they are cognitively and effectively connected to a learning experience.

" For the first time I was exposed to such a vast number of vocabulary at once, I really got to learn many words" In a first language , as the learner encounters most words on a frequent basis in a wide range of contexts, the words are often learned incidentally in an incremental way. In a short space of time, a large number of words are thus learned and this lexical repertoire then forms the basis for learning other new words. In this research we tried to simulate the process of implicit vocabulary learning. A selected number of high frequency words were chosen and integrated in the game to help students learn incidentally. They were exposed to a large quantity of input, a condition that otherwise was impossible to achieve for non-native speakers. We provide a cumulative learning environment; different vocabularies were continuously encountered to allow the learning of each word to become stronger and to enrich the knowledge of each word.

However, they also showed that the learners continued to make certain persistent spelling errors, even after playing quite a few times (Table 1). In other words, a communicative approach helped learners to become fluent but was insufficient to ensure comparable levels of accuracy. It seems as if a certain amount of explicit instruction focusing on language form may be necessary as well. As a further refinement to our package we added a few word games and dictionaries to the package, focusing only on technical and non-technical vocabularies that students encountered in MOBO city games.

1. A word search game that comprised seemingly random letters arranged in a rectangular grid. A list of 10 hidden words is provided. The object of the game is to find and mark all of the words hidden in the grid. The first letter of each word provided the cue which was accessible by the command 'Cue' at the bottom of the screen.

2. A 'Butterfly shooter' game was created where a butterfly represented the player. The meaning of a random word was given at the bottom of the screen. By shooting the red bullet towards the rolling balls, one could choose one's desired letter. Each time a bullet hit the wrong letter, the butterfly lost a wing. On losing all its 6 wings, the game terminates. A bilingual single-field dictionary was produced that narrowly covered computer engineering terms, in Farsi and English.

CONCLUSION

Effective learning cannot be achieved by only introducing different modes of learning, but also requires increasing students' motivation and keeping them motivated and engaged until the educational goals are achieved. In educational games, the learner will be immersed in the context which is achieved by designing a suitable theme appropriate to learners. Elements of control and a sense of danger were incorporated into our game and thematic feedback was delivered as appropriate. For example, if the learner has made an incorrect choice, dialogue from a character provided a feedback mechanism. All this produced an immersive experience that helped students learn vocabulary incidentally, as they were having fun. Deliberate vocabulary learning was also added to our package to help students solve their common errors. In this game we illustrated a simplistic illustration of components and different processes of computers. It is possible to elaborate on extra features and expand this game for the future. For example other kinds of buses such as control bus, address bus and power bus could be described. The motherboard has different components, and some motherboards are designed for multiprogramming and multiprocessing. There are many other examples that can be thought of. When adding new features and new components, new environments and characters must be designed. In the process, different storylines will evolve. Further learning content such as this can help to enrich the game further and to teach students even more vocabulary. Future work on this project will attempt to provide social interaction between students while playing. By adding Bluetooth capabilities, we are aiming to produce multiplayer version of this game. The shared experiences could greatly increase the appeal and longevity of the game and works as a powerful motivator to engage girls within the educational content.

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Designing Tasks for Engaging Mobile Learning

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ABSTRACT
Many mobile learning projects aim to support new learning forms like situated learning in a real world environment. Situated and explorative learning should be active learning, engaging students in the environment. We tested four different tasks designs in two large field tests with the mExplorer system. Two kinds of engaging tasks were observed. Interactive tasks with high context integration led to knowledge about specific aspects of an environment. Creative tasks led to a familiarization with the environment. We also analyzed other projects with situated real world learning scenarios to see what types of tasks they were using. We found that instead of sup-porting active learning, many of these projects still focus on transmissive elements and do not use the full potential of situated and explorative learning. To optimize this, we propose four design recommendations for tasks and de-scribe the circumstances under which specific types of m-learning tasks should be used.

Author Keywords
Tasks design, engagement of learner, evaluation of tasks

INTRODUCTION

The field of mobile learning is growing rapidly. Frohberg (Frohberg 2007) identifies approximately 150 projects in this research area. One of the first definitions of Mobile Learning is from O'Malley et al. (O'Malley, Vavoula et al. 2003):

"Any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies."

This definition concentrates mainly on the technical aspect and shows the first stages when projects adapted the traditional scenarios of classroom based learning to new technologies. Examples are the streaming of university lectures to mobile phones (Qi, Wang et al. 2006) or learning vocabulary on streetcars (Thornton and Houser 2004). A more modern view is less technology driven, but mainly focusses on the learning issues. This leads to the following definition (Göth, Frohberg et al. 2007):

Mobile learning is learning of mobile actors. In contrast to other mobile activities (e.g., for pleasure or work), mobile learning activities are embedded in a didactic framework. Computer science research is interested in those mobile learning approaches that are supported with mobile technologies.

More and more researchers are realising the potential of supporting new learning forms with mobile technologies. One such learning form is situated learning in the real world. In this environment, the learning place and natural context are the same, like in a botanic garden (Naismith, Lonsdale et al. 2005) where students learn something about the fauna and flora (Weal, Michaelides et al. 2003), or a zoo where they get to know more about animals. This learning form is based on the socialcultural constructivism (Hutchins 1995) and situated learning (Reinmann-Rothmeier and Mandl 2001). The teacher has the function of a coach and the learner changes from a passive to an active learner. The *passive* learner accumulates declarative knowledge by consuming prepared learning material which can't be used directly (Baumgartner and Payr 1994). The *active* learner acquires knowledge and skills in an authentic real world setting with real problems. This setting engages the learner and leads him to a sustainable and usable increase of knowledge (Reinmann-Rothmeier and Mandl 2001). In this setting, guidance may be provided through mobile (Frohberg and Schenk 2008). It provides information, instructions and a communication channel to other learners and to the teacher.

The challenge is to implement this learning scenario in an effective way. The analysis of other projects (see section 6) shows that many projects aim to support learning in a real world scenario, but do not really involve the learner. Thus these projects do not use the full potential of this learning form since, instead of exploring the environment actively, the learner moves on predefined routes and consumes the prepared information.

Typically, the main obstacle facing researchers and practitioners is not the design of the technology, but rather the designing of appropriate tasks. If they are not sufficiently attractive, learners just ignore them. If they are too easy, they move rapidly from one task to the next without learning appropriating. If a task is too complicated and is also accompanied with a low level of guidance, the learner is confused and feels helpless in the environment, not knowing what to do.

This paper presents the results of four types of tasks (section 3 to 5). The results show that appropriate tasks can be designed for activating and engaging learners. Further, the type of tasks that other projects used (section 6) are analysed.

The previously reported (section 2) engagement framework used for the analysis of the field tests results and the other projects is also discussed. The paper concludes with four design recommendations for mobile learning tasks (section 7).

THE ENGAGEMENT FRAMEWORK

The notion of engagement describes the state in which a person "holds attention" of an object or event (Webster 2003). This causes him to interact with it, work with it or think about it in a cognitive active way. The level of engagement describes then how much the person is interested, works, interacts or thinks about it.

Situated learning in a real world scenario is aimed to increased *engagement* of learners by using the environment (Reinmann-Rothmeier and Mandl 2001). Mobile learning technologies have the potential to support the incensement. In order to understand the engaging influence of different mobile learning tasks, one has to understand the engaging influence of different pedagogies.

We distinguish three types of pedagogies leading to different engagement levels (a detailed discussion on this issues can be found in (Göth, Frohberg et al. 2007)): transmissive learning, interactive learning and explorative learning (see Figure 22). We briefly introduce these pedagogies in the mobile learning context:

Transmissive learning is the behaviouristic supply of prepared multimedia content to the learner (Taylor, Sharp et al. 2003; Crawford 2004). This content is presented on the mobile device and is consumed by the learner. The learner engages with the environment by observing it (if he is not distracted too much by the device (Goth, Frohberg et al. 2006)). This observation does not require any subsequent activity. We regard this as "low engagement" with the environment.

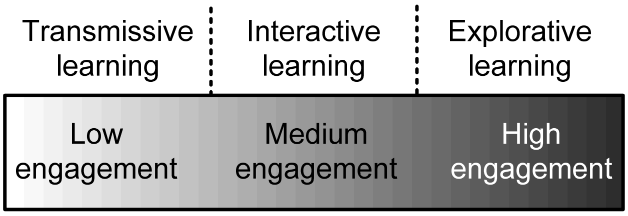

Figure 22: Level of engagement in different pedagogically driven types of learning

In an **interactive learning** scenario, the learner first observes the environment or performs some higher level information task in the environment, e.g., searching. In a second step, he enters the results of this task to the computer, e.g., through multiple choice quizzes, the documentation of a context with pictures, annotations, voice recorded notes or the collecting of measured data from sensors. The learner is thus engaged in some interaction related to the natural environment. This interaction is still purely with the computer and does not leave any traces in the natural environment. We regard this as "medium engagement" with the environment.

Explorative learning is learning in the environment with its objects (Reinmann-Rothmeier and Mandl 2001). Learners do not purely observe an environment but explore it by actively interacting with it. These activities may actually change the environment itself. Just as the explorers did in the 16th century, learners may leave landmarks signalling their presence; their explorative activities may even have devastating effects. Mobile technologies allow them to freely change the digital parts of a mixed reality environment, e.g., by annotating it. Explorative learning is characterized by a necessity of a mentally and physically active exploration, that is, one which also challenges learners in a cognitive way. This provokes curiosity, leading to further experiments, reflection, scrutinizing of what is seen, and discussions with other learners. In such a situation, the highly engaged learners acquire self-constructed and useable knowledge.

THE MEXPLORER SCENARIO

The mExplorer is used during orientation days at the university. The traditional orientation rally is electronically supplemented with handheld devices. The orientation rally is a fun event aimed at familiarising the students with the university buildings and their surroundings. Thus, the rally leads participants through an area with several tasks to accomplish at specific spots. The students play in small teams against another. Each team has a handheld computer.

The handheld device shows the current position of the team on the digital map of the university. When the team enters a building, the outdoor map switches to an indoor map of the building that the team has just entered.

During the orientation rally, each team receives different tasks that refer to important places. The students have to find relevant places, such as the library, the cafeteria or the laboratories. These locations are also marked on the digital map. At each location, they have to perform a typical task (find a book, have lunch, etc.) for which the handheld device supports the task execution (e.g., providing required information). These tasks can be designed in different ways. The current realised and tested forms will be discussed in the next section.

In addition to the tasks, there is a fun element integrated into the game with the aim of keeping the teams alert. Each team tries to catch another team and is simultaneously hunted by a third team. The handheld device shows each team where its hunter and its prey are located.

METHOD: FIELD TESTS

The learning goal of the mExplorer is the familiarisation with the university campus; however, learners should explore the campus by themselves, guided by the different tasks. Following the piloting research approach (Schwabe and Krcmar 2000), two field tests were used to get results of engagement through tasks from real learners. To discover the best tasks for learning, four types of tasks were compared:

- **Points of interest**: The points of interest (PoI) are locations which are important for students and university life, such as the cafeteria, the student office or student clubs. These points are marked on the digital map of the handheld device. The students can find additional information about the location by simply clicking on the marker on the digital map. The students can navigate to these PoI and explore them.
- **Interactive tasks with low context integration**: Interactive tasks with low context integration are interactive questions that only superficially relate to the location. For example, one task of mExplorer requests the students to go to a computer room and count the chairs. The question is location specific, because the answer depends on a specific room that has a specific number of chairs in it. But the question could have been asked of any other room; it was not specific to the Computer Room.
- **Interactive tasks with high context integration:** Interactive tasks with high context integration are tasks which really depend on a specific location in a specific environment. For example, tasks targeted at unique characteristics of the library of the University of Zurich are tasks with high context integration. Typically, these tasks are more complex than tasks with low context integration because they are specific to the environment and provide the learner with more details of it. In our case, the interactive tasks had the limitation being multiple choice answers. The pedagical motivation for this was to give the students direct feedback on the correctness of their answers through the system. To do this, the answer had to be unique.
- **Creative tasks:** These tasks allow for a wide range of answers and the opportunity to be creative. This type of task focuses more on performing rather than on discovering. For example, the students are asked to write a love poem to a photocopier. This type of tasks was developed later in the development process of the mExplorer because of the disappointing results of PoIs and interactive tasks with low context integration in prior tests (see results below).

In the first field test the PoI were compared with interactive tasks with low context integration and interactive tasks with high context integration. After the test the creative tasks were developed and integrated in the mExplorer. In the second field test interactive tasks with low context integration and interactive tasks with high context integration were compared with creative tasks. PoI were not tested because of the bad results in first field test.

First field test: At the beginning of the winter term 2005 students of an introductory course in computer science were asked to participate in a game that introduced them to the Irchel campus of the University of Zurich. The majority of the students (61%) were computer scientists; the rest were mainly enrolled in natural sciences. 26% of the population was female and the average age of the participants was 23 years. 41 students played the mExplorer game on one of three possible dates. Each game then lasted approximately 60 to 90 minutes. During this time the students had to navigate to 7 location-specific tasks and fulfil them. 4 of these tasks were interactive tasks with low context integration and 3 were interactive tasks with high context integration. Additionally, they had to visit 18 PoI.

At the end of each game, each player was given a first post-questionnaire comprised of questions related to their general impression of the tasks, the PoI and the technique. Additionally, two persons of each run were observed during the game and interviewed afterwards.

Second field test : The second field test took place in June 2006 during a demonstration of mobile learning. Five teachers and 15 high school students played the mExplorer game. The average age of students was 17 years and that of teachers was 39. Overall, the average age was 22.5 years with 45% of the participants being female.

After a short introduction to the mExplorer system, they played a game of about 60 minutes. During this time they had to navigate to and fulfill seven location specific tasks (5 interactive tasks and 2 creative tasks). They could also hunt each other and chat together. After the game, each participant was given a questionnaire with questions related to their general impressions and specific tasks.

RESULTS

Points of interest

We felt the results of the PoI were disillusioning. In the interviews the students of the first field test could only remember on average 1.8 of the 18 PoI. The learners reported ignoring them totally. The ratings of the PoI were ordinary 2.97 on fun and 2.56 on benefit[17] (scale from 1 (very low) to 5 (very high); N = 40). Thus, the intended effect of engaging the learner for further exploration did not occur. Although the PoIs were marked on the map, the students neither visited nor explored these locations.

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[17] The students were not asked directly to benefit. The value was calculated from question of how much they ignored the PoI.

This is understandable when the PoI are categorised with the engagement framework. The intended learning scenario of the PoI is transmissive learning. The students move to the location and consume the prepared information there. However, the intended effect of an additional exploration and cognitive processing did not happen. The learners remained in a passive role and the level of engagement was low.

Overall, the results on PoI show that this type of passive tasks where students consume prepared information is inappropriate for activating learners in a setting of situated explorative learning.

Interactive tasks with low context integration

The idea behind interactive tasks with low context integration was to lead students to specific and important places, such as the PoI. Since they receive points for the fulfilment of the tasks, they will not ignore them. Afterwards, the location itself should raise enough curiosity to engage the learner in further exploration. In the four tasks of the field test the students were asked for counting the chairs in a computer room, discovering the location for getting forms from the secretary, detecting that there was no lecture in a toilet room, and finding that they could deliver homework to a letterbox.

The results to these tasks were similar to the results of the PoI. The only difference was that the students did not ignore the tasks and actually went to the locations. But no further exploration happened. This leads to the bad rating of 2.91 on fun and 2.71 on benefit (scale from 1 (very low) to 5 (very high); N = 87). It is quite similar to the results of the PoI. A T-Test shows, that there is no statistically significant difference between PoI and interactive tasks with low context integration (Sign. on fun = 0.758 and on benefit = 0.453).

The classification of these tasks into the engegment framework is also similar to the PoI. The learning scenario behind the tasks is only pseudo interactive. The students had to count something and write the correct number down or had to select one obviously right answer out of two others. These simple questions did not change the role of the learner from passive to active. The engagement was a little improved compared to the PoI because the students did not ignore the tasks, but it was still low. The overall results did not differ significantly from those of PoI.

Interactive tasks with high context integration

Three tasks with high context integration were tested:

- **Library**: The students had to find some information out of one specific book. To fulfil this task they had to find the library, learn to handle the library information system to write down the code of the book, understand the library code and the organisation of the library, and finally locate the book.
- **Computer club and Wi-Fi**: The students had to find the computer club and learn to insert their own laptop into the university Wi-Fi network. To fulfil these tasks, the students had to find the computer club, meet the club's president and hear what this computer club was about, learn how to insert a computer into the Wi-Fi network, and finally insert a computer into the Wi-Fi network on their own.
- **Information system and lecture hall**: The students had to find a password which was placed on the door of an unknown lecture hall. The room number of this lecture hall was obtained from a specific university assistant. To fulfil the tasks, the students had to find the university information point, learn to use this information system to get the telephone number of the assistant, call the assistant, understand the room number (e.g., Y27-G24), learn to navigate with this code and finally find the lecture hall.

The results from these three tasks were different from the tasks with low context integration and the PoI. The students explored the environment on their own to fulfil the tasks. They reflected on the tasks and their further actions and interacted with others, that is, they asked other students or the library staff if they needed help. With this complexity and context integration, they were absorbed by the environment. This resulted in a better rating of these tasks. The fun of these tasks was rated with 3.35 and the benefit was rated with 3.98 (scale from 1 (very low) to 5 (very high); N = 66). A T-Test showed a statistic significant difference between the PoI (Sign. on fun = 0.035 and on benefit = 0.000) and the interactive tasks with low context integration (Sign. on fun = 0.006 and on benefit = 0.000).

The classification in the engagement framework also showed a difference. From a pedagogical point of view, these tasks supported real interactive learning with explorative appendages, leading to higher engagement.

Overall, the results of this type of tasks are much better than those of the PoI and the tasks of low context integration; that is, this type of tasks leads to a better interaction with the environment and examination of its particularities while the learner is fulfilling the tasks. But the problem is that there is still only low engagement and attention given to the environment between the fulfilment of the different tasks. After the game the learner knows how to search for and borrow a book form the university library or how to find a specific room on the university campus; however, the familiarity with the campus as a whole is low.

Creative tasks

There were two creative tasks tested:

- **Measurement**: The learners measure the distance between the two largest lecture halls in a self invented and creative way.
- **Poem**: The students write a short love poem to a photocopier located beside the cafeteria.

The answers were given as an annotation to the tasks on the digital map of the handheld device. In this way, the player could see the former answers of other players. The idea was to encourage creativity.

The creative tasks were a great success. The students explored their environment very actively and thought about possible replies, reflected on their actions and gave creative answers. Also, the encouragement through the other answers worked great. The first answers to the measurement tasks (“35 footsteps” and “118 lengths of shoes with size 42”) were not very creative, but soon one answer after another became more creative. The next group answered “32 umbrella lengths”, then “3.500.000 hair lengths” and the last groups answered with 30 human rotations. Here one learner laid down on the floor and measured how many rations he needed from one lecture hall to the other.

The ratings of the tasks confirm the observed positive effect. The participants rated the fun with 3.95 and the benefit with 2.00 (Scale from 1 (very low) to 5 (very high); N = 38). So the students had a lot of fun and experienced a great emotional link with the locations of the creative tasks. But they did not see much benefit in it. One possible reason for this is that the participants were not students; accordingly, the university was not in their focus of interest. The rating of the benefit of the interactive tasks with 2.53 confirms this, being much lower than the rating of normal students. A further reason might concern the type of acquired information. These tasks should serve to familiarise the learners with the place where the creative tasks were accomplished and mediate no factual knowledge about it. From the gamers’ perspective, this could be seen as no gain of new knowledge or the learner wasn’t aware that he was learning. The problem is the learner’s perception of learning. He believes that if it does not happen in a classroom or with specific tasks, it cannot be learning.

But the pedagogical frameworks show the high engagement. These tasks are explorative, situated and creative which lead to high engagement. A T-Test between the creative tasks and the interactive tasks also show a statistic significant different (sign. on fun = 0.034 and on benefit = 0.021).

Overall, the engagement of the learners was very good with this kind of creative tasks. The familiarisation works very well and the learners had a lot of fun. But their cognition was not learning and the benefit was not obvious to them.

Summary

The field test results (see Table 6) show that creative tasks and interactive tasks with high context integration were rated as having the most fun. The players had much more fun than with PoI or interactive tasks with low context integration. And this difference is statistically significant.

Median of fun and benefit

	Fun	Benefit	N
PoI	2,97	2,56	40
LC	2,91	2,71	87
HC	3,35	3,98	66
Creative	3,95	2,00	38

Results on fun

	PoI	LC	HC	Creative
PoI	x	x	x	x
LC	<	x	x	x
HC	>*	>*	x	x
Creative	>*	>*	>*	x

Results on benefit

	PoI	LC	HC	Creative
PoI	x	x	x	x
LC	>	x	x	x
HC	>*	>*	x	x
Creative	<*	<*	<*	x

** = Significant on a 5 % level*

LC = Task with low context / HC = Tasks with high context

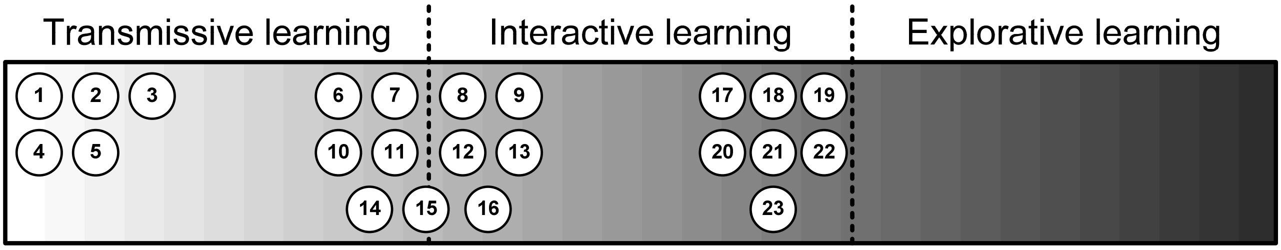
Table 6: Overview of the results

The benefit of interactive tasks was rated best. The rating is statistically significant and higher than all other types of tasks. The result benefits of creative tasks are conspicuous. Although they lead to the most fun, the benefit is rated lowest.

This indicates clearly that interactive tasks with high context integration and creative tasks have a high potential of engaging the learner in the environment. After these results of the field test were gained, an analysis of other m-learning projects with situated real world learning scenarios was undertaken to see what kind of tasks they were using.

ANALYSES OF OTHER M-LEARNING PROJECTS

For the analysis of the tasks design, 23 projects of Frohbergs (Frohberg 2007) category “physical context” were used These were the 23 (out of 150 projects) which supported situated learning in a real world environment. Their aim was to engage the learner by the use of explorative learning. But the analyse shows that they typically do not use this learning form (seeFigure 23). 5 out of the 23 projects mainly focus on transmissive elements of which SottoVoce (Woodruff, Aoki et al. 2001) is a typical example. The system provides additionally prepared information to a specific exhibit in a museum. The learning happens in a real world environment but instead of supporting a real exploration, the basic learning scenario is that of a guided tour, the only difference being that the guide is replaced by a mobile device.



1	**SottoVoce (Woodruff, Aoki et al. 2001)**	**13**	**MLP (Yang and Chen 2006)**
2	**SomersTown (Bradley, Haynes et al. 2005)**	**14**	**Gipsy (Wentzel, Van Lammeren et al. 2005)**
3	**Guide (Cheverst, Davies et al. 2000)**	**15**	**MIT-Projects (MIT 2005)**
4	**Caerus (Naismith, Sharples et al. 2005)**	**16**	**Archie (Van Loon, Gabriëls et al. 2006)**
5	**ME-Learning (Crom and Jager 2005)**	**17**	**TreasureHunter (Chang, Chang et al. 2006)**
6	**MMT(Tate) (Proctor and Burton 2003)**	**18**	**Raft (Rentoul, Hine et al. 2003)**
7	**Exploratorium (Hsi 2003; Hsi 2004)**	**19**	**CCProbeware (Consortium)**
8	**Musex (Yatani, Sugimoto et al. 2004)**	**20**	**KingMiddle (Lehner, Nösekabel et al. 2003)**
9	**MyArtSpace (Vavoula, Meek et al. 2006)**	**21**	**DenaliPark (Consortium 2004)**
10	**BWL I+II (Chen, Kao et al. 2004; Chen, Kao et al. 2004)**	**22**	**Enlace (Verdejo, Celorrio et al. 2006)**
11	**Moop (Mattila 2006)**	**23**	**MeadSchool (Lehner, Nösekabel et al. 2003)**
12	**AmbientWood (Weal, Michaelides et al. 2003)**		

Figure 23: Analyses overview

A further 11 (out of 23) projects support interactive and transmissve learning. But the transmissive elements are also dominant in the various learning scenarios. The interactive elements consist only of short quiz questions which test whether the leaner has visited a specific location or has consumed the information about a specific object. An example of this is the MMT Project (Proctor and Burton 2003) where the visitors of a museum - like in the SottoVoce project - get a digital guide. Additional to the prepared information, the learner gets short questions to check his attention to the presented information. Although he can also annotate the objects, the core of the learning scenario is the prepared information.

The last 7 (out of 23) projects have their focus on interactive elements. TreasureHunter (Chang, Chang et al. 2006) also uses short quiz questions to check visited locations but it doesn't give further information. The other six projects are similar to KingMiddle (Lehner, Nösekabel et al. 2003) where the mobile device is used as a sensor and learners have to take measurements of rainwater. The goal is to learn more about the drinking water supply of a city. The mobile device also tracks the position of the several measuring points. The interactive elements here are limited to the sensor. The actual learning happens later in the classroom where the evaluation of the collected data takes place.

None of the 23 projects supports real explorative learning. This shows that the potential of engagement of learners with the environment through tasks is not yet fully used. For better task design, we propose the following design recommendations.

DESIGN RECOMMENDATIONS FOR TASKS IN SITUATED REAL WORLD LEARNING SCENARIOS

Based on the results and the experience of the field tests, four design recommendations to optimize the engagement through tasks in a situated real world learning scenario are provided.

Reduce transmissive learning techniques in situated real world learning scenarios: Players totally ignore the Points PoI. They have only low fun and consider the benefit to be low. The comparison to the other tasks shows that the learner wants to be in an active role and does not like to consume prepared information. In the active learning scenario where the learners can do several other things, like exploring the environment or fulfil other interactive tasks, the usage of transmissive technique is inadequate for learning. Even if no mobile learning scenario can work without transmissive elements (e.g., giving basic information, guidance and instructions), designers of learning scenarios should not focus on these elements and strive to reduce them.

Use tasks with high context integration in situated real world learning scenarios: The results of the field tests show that learners prefer tasks with high context integration. The idea of bringing players to locations by using tasks with low context integration in the hope that the location will lead to further exploration does not work. The players will go there to fulfil the unspecified tasks and then move away, ignoring the rest of the location. To engage the learners, the tasks need to be explicitly designed for the specific characteristics of this unique location. By using these characteristics and interacting with them, learners will be absorbed by the environment, gaining more fun and benefit.

Use interactive tasks with high context integration to teach specific aspects of an environment: The engagement which is provided by the context integration should lead to intensive cognitive exploration and reflection of the environment. The goal is to teach learners more about the environment. The results show that interactive tasks with high context integration are the best for teaching specific aspects, such as how to borrow a book or insert a laptop to the Wi-Fi network. By searching for possible answers, student learns how the current context works. In this way, learners are highly engaged, explore the environment of the tasks to fulfil them, and have a lot of fun.

Use creative tasks for familiarization: Apart from the mediation of knowledge about specific aspects of the environment, the familiarization with the environment as a whole may be a learning goal. Learners should get an emotional association to the location. Here creative tasks work great. The learners explore and interact with the environment, are highly engaged and have a lot of fun. The intensive examination and exploration of the environment leads to a greater familiarization. The disadvantage is that the learning goal is not as specific as the goal of interactive tasks. It is not predictable what exactly the learner will learn. But the emotional link and the familiarisation is better than with the interactive tasks.

CONCLUSION AND FURTHER RESEARCH

Many current mobile learning projects are not using the full potential of the situated real world learning scenario for engaging the learner. Task design is a key factor for using the full power of engagement. Instead of working only on improving technology, more work should focus on pedagogical task design. An improved task design may then lead to insights on which technological improvements are worthwhile. The goal is not to use the full potential of the technology but to use the full power of the learning scenario to maximize learning. By using interactive tasks with high context integration and creative tasks, the learner is engaged in exploring the environment. The next research step is to explore how to design good interactive and creative tasks.

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Mobile Phones for Learning in Mainstream Schooling: Resistance and Change

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ABSTRACT

This paper, based on empirical research, considers how structure and agency together reproduce the social practices surrounding mobile phone use in secondary schools in the United Kingdom. Many schools have policies banning their use in class, reflecting and supporting the dominant social construction of mobile phones as tools for social use, but not for learning. This study aimed to understand how mobile phones could support learning in secondary schools, and identified activities across many subject areas and year levels. It also showed that hands-on experience had a positive effect on students' attitudes to mobile phones for learning in school. The results indicated that decisions on ownership of devices and technical issues in integrating mobile phones with networks and virtual learning environments are important considerations for schools wishing to use mobile phones for learning. It concluded that teachers have a great deal of agency, and that they display this by innovating or resisting change.

Keywords

Mobile phones, secondary school, social theory, culture, structure, agency

INTRODUCTION

By the time they reach secondary school, 91% of 12 year olds in the UK have a mobile phone (LSE, 2006). Nowadays these devices often provide clock, calendar, games, music player, Bluetooth connection, internet access, and high-quality camera functions in addition to voice calls and short messaging. Recent models allow users to read portable document file (pdf) formats, spreadsheets and word-processed files, but they have rarely been seen as tools for learning. Further, mobile phones in schools have attracted media attention, promoting the view that they are disruptive technologies, in a negative sense. When a Government Minister urged parents not to allow their children to take their 'Christmas toys', such as mobile phones, to school, he was backed by the general secretary of a teaching union (BBC, 2007a). Many schools in many countries ban their use in class, and document this in written policies. Where they are allowed, existing practice tends to focus on social and administrative uses, such as sending text messages for reminders or delivering exam results (Board of Studies NSW, 2005). Thus in spite of their functionality and potential for learning, mobile phones themselves are stigmatised, because 'mobile phone' is a socially-constructed term referring not just to the physical artifact, but constituted by advertising, politicians and teachers. They have even been referred to as potentially offensive weapons (BBC, 2007b). This has led to calls for a new name for the devices (Hartnell-Young, 2005) and makes this study very timely.

A fundamental difference between mobile phones and the handheld computers that have been introduced into schools through other projects is that most students already own mobile phones. This project raised a new set of issues to do with ownership of computing devices, security of school networks, and societal perceptions of device use. To understand what is occurring in relation to mobile phones in schools, we considered the schools as social systems which are themselves part of a larger system, and explored the nature of control and change in relation to teachers and students, policies and culture. Control system models, based on cybernetics, can help us to understand how actors enact social roles with enough stability to preserve institutional arrangements, while still demonstrating creativity (Robinson, 2007). Social theory, particularly Giddens' (1984) structuration theory, suggests a duality that involves human agency and structure, and argues that the structural properties of social systems exist only insofar as forms of social conduct are reproduced across time and space, and that social practices ordered across time and space are the basic domain of study. The social structure includes traditions, institutions, moral codes, and established ways of doing things exist at the macro scale, yet these can be changed by human agency when people ignore, replace, or reproduce them differently. For Giddens, routinisation is a fundamental concept of structuration theory, as is power. He sees formulated rules (such as written policies) as codified interpretations of the rules or techniques applied in reproducing social practice. Of interest to this research is how individual schools produce and reproduce a culture that supports learning, in this case with the support of mobile phones.

Structure is regarded as rules and resources implicated in social reproduction, and institutionalised features of social systems like schools have structural properties in the relationships that are stabilised across time and space. Broadly, in a secondary school system the curriculum, accountability mechanisms such as policies and examinations provide the structure, as do the hierarchical relationships between people, and the routines that have changed little over many years. Individually and collectively teachers, students and the wider community act as agents to differing degrees. At the micro scale, teachers are usually expected to display 'control' in classrooms, and the introduction of communication technologies into schools has challenged this in two ways: teachers realised that many of their students had more computer skills that they did, and by accessing information on the Internet, could also gain more information than their teachers (Green, Facer, Rudd, Dillon, & Humphreys, 2005; Green & Hannon, 2007). Thus a shift in power relations in classrooms is occurring, resulting in many teachers taking on learning behaviours beside their students (Hartnell-Young, in press), as in a community of practice (Wenger, 1998), which allows for both central (expert) and peripheral participation. Similarly, constructivist approaches value learner autonomy and control of their learning (Becker & Riel, 1999; Brooks & Brooks, 1993; Brown, 1987) encouraging learners to take risks and develop the insight necessary to improve their own learning.

A paradox is that while the rhetoric values autonomy for students, as structural accountability regimes increased in recent years, teachers have claimed to experience reduced autonomy and sense of agency. In relation to introducing mobile devices in schools, McFarlane, Roche and Triggs (2007) suggested that it was teachers' confidence, relationship with their classes and attitude to taking risks that have the greatest effect on implementation of such technologies. These can be construed as aspects and consequences of personal agency, as clearly one way to maintain some autonomy is to resist change. In light of this, Roschelle (2003) described potential uses for wireless mobile devices in class, reassuring readers that since 'attention is teacher's most precious commodity' (p.266) certain devices ensure that 'teacher-controlled communications predominate'. He recognised that a school is not a simple place to introduce a wireless mobile device, but suggested that teachers might be able to 'maintain control' by disabling certain mainstream applications, including the Internet. Facer, Faux and McFarlane (2005) claimed there is a need to consider the nature of the control gained by students and relinquished by teachers, as if this is a zero-sum game. In the project they described, they noted that in some cases, student use of the devices was teacher-led rather than student-driven, and suggested that this was caused by the perceived rigidity of the curriculum. They might have exaggerated the strength of this structural influence, as teachers in the same national system show agency by innovating. Therefore while teachers might form a structural category in the hierarchy, they behave differently, as do students.

Schools are made up of various system components and structures, including individuals, classroom units and policies. Accountability and management regimes are often predicated on tight coupling of components, while innovation is often likely to result in loosely-coupled systems (Weick, 1976). Secondary schools in general may be more loosely coupled than primaries, as they tend to be organised into subject departments and are larger in population, leading to more administrative units such as year levels. This can make top-down change harder to implement, but provides a condition for ground-up innovation in smaller areas than the whole school. In this study we attempted to capitalise on this loose coupling.

Other research has considered mobile phone use on the edges of schooling (Attewell, 2005; Hartnell-Young & Vetere, 2005, 2006), where in terms of accountability the stakes are not so high, whereas this project specifically looked at mainstream schools. Perry (2006) and McFarlane, Roche and Triggs (2007) noted concerns about introducing mobile devices (in their cases PDAs) into secondary schools, citing teacher agency issues including lack of imagination, knowledge of device capability, fear of bullying and lack of privacy. Thus study worked with and through teachers to clarify these issues.

METHOD

This paper addresses the research question: 'How do structure and agency reproduce the social practices surrounding mobile phone use in schools?' Sub-questions considered how mobile devices could support learning in secondary schools and how school cultures could influence the future integration of mobile phones into everyday practice. The methods were designed to share the control of the research with teachers, and engage with them in many aspects of planning the original funding proposal, data collection and reporting. We drew on the literature of teachers as researchers, a role that recognises teacher agency and legitimacy in researching practice. Hopkins (2002) argued that it is not sufficient for teachers to do research in their own classrooms without relating their enquiries to the work of their colleagues and the aims and direction of the school. In this way a synthesis between teacher research and school development would occur, resulting also in teacher learning. This raised a dilemma for our research: while the project supported all schools' aims of increasing technology support for learning, it disrupted the policies that ban mobile phones in class. One school established a project reporting space for all the participating teachers on its virtual learning environment (learning platform). However we found it was mainly used by teachers in that school, whereas in other schools, some of the teachers referred to the project as 'your research' rather than expressing the ownership we had hoped.

Three sets of teachers volunteered to be involved from the outset, from two single schools and one cluster, labelled A, B and C. Therefore they were not representative of all teachers in schools and could have been expected to have a strong sense of agency in relation to effecting change. The students were studying the National Curriculum and preparing for examinations. The teachers chose individuals and class groups to participate, with the result that the cohort comprised the range of students in various Year levels and subjects shown in Table 1.

	School A	School B Stage 1	Stage 2	Cluster C Stage 1	Stage 2
No of teachers	2	2	2	3	3
No of students	20	4	14	12	147
Subject & level	Science Year 10/11	Various subjects Yrs 9, 11, 13	Design Technology Year 11	Geography Year 9	Geography Year 9
Device & access	Students' own phones & sim cards, 24/7	Nokia N80s with students' own sim cards, 24/7	Nokia N95s with students' own sim cards, 24/7	Nokia N80s with loan sim cards, specific lessons	
Survey 1	21	151		12	147
Survey 2	16		12		73

Table 1: Characteristics of participants and devices used

The teachers–rather than the research team–chose the activities and the extent of participation for each group, in a purposive manner, and liaised with the university team.. Importantly, three different approaches developed, as outlined in the table above. School A students used their own phones 24/7 for approximately nine months. School B students used their own sim cards in 'unlocked' smart phones 24/7 for nine months, meaning that they could use any phone company. This meant that in schools A and B students' regular phone numbers could be used at all times. In C all students used a set of unlocked smart phones (with one device shared between every two students). These were lent by the university, with sim cards included, and used for periods of less than a day, so there was no opportunity to personalise, or take control of, the device.

In each school, the same baseline survey was conducted by the teachers, followed by a similar survey with additional questions towards the end of the project. Due to the time span of the project, the cohorts surveyed were not identical, so the unit of analysis was the school, or in some cases, the whole cohort. (This is consistent with the social theory approach taken in this paper). The survey covered current attitudes, as an indication of both agency and school culture, and current practices with mobile phones. Some of the teacher-researchers conducted interviews of participating students and teachers and in addition, the university team visited each school and interviewed teachers and students separately, in a form of triangulation. The interview schedule included reasons for choosing to work with mobile phones, appropriate tasks, connection with other technologies, instances of collaboration and unexpected outcomes. All interviews were transcribed and the team met initially to code from the ground up, checking reliability and revealing themes for future discussion with participants. Finally the data were considered with reference to Giddens' structuration theory. In terms of empirical research, the theory considers agents (people) as knowledgeable, and researchers should pay attention to many forms of 'discursive phenomena' and to 'practical consciousness'. Like Nonaka and Takeuchi's (1995) explicit and tacit knowledge, this means that researchers must consider comments outside formal interviews, email communications, and documentary or photographic evidence that helps to reveal what people think and do.

FINDINGS

In this section the data relating to elements of the secondary school system are presented, using examples identified by school. Mobile phones were constructed over time in several ways: by the small number of teachers involved as cameras and handheld computers to use for learning, and by the written school policies as possibly useful for communication, but disruptions to teaching and learning. At the outset students generally saw them as social tools (almost 50% of the School A students and 30% of the School B students could not even think of any useful learning applications) and as one student told us, his peers felt 'It can't possibly be a learning device, it's a mobile phone.'

Structure

In the secondary school system the curriculum and internal and external accountability mechanisms including policies, examinations and league tables provide the structure, as do the hierarchical relationships between people, and the routines that have changed little over many years. Each school had a specific written policy that banned mobile phones in classes. School A was a specialist media and technology college, with good media resources. The school's mobile phone policy stated 'Students must keep phones switched off and out of sight in lessons and in the College building…In exceptional circumstances, such as a family emergency, students should seek staff permission to use their phone.' School B proudly claimed that its 'physical resources are supplemented by an award winning virtual learning environment, with extensive use of wireless technology and the intranet ensuring that learning materials are always available to students on line. This means that the learning journey can begin and continue well beyond the traditional school day.' But it had a clear policy for students in Years 7 to 11: 'we do not allow mobile phones in school.' The school justified this stance by equating mobile phones with other technologies, specifically 'Walkmans, laser pens, cyberpets and other devices which could interfere with the quality of teaching.' School C expressed its policy most strongly:

> Any use of a mobile phone, whether it is for calls, messaging, photographs or games during the school day is strictly prohibited. The school has adopted these rules because the use of mobile phones in school can be highly disruptive.

In order to assess the influence of these policies 331 students were asked what the policy of their school was (given 4 categories), and their replies generally reflected the written policy, with 92% across the three sites stating that mobile phones were not allowed in class. Actually, however, the policies and practice were loosely coupled, particularly in School A, where teachers already allowed reasonable use of mobile phones, and some were prepared to ignore students listening to music on their phones in classrooms if they were also obviously working. Further, one teacher in School A said 'There's a general policy, but within that policy there may be pockets of innovation where people try to use mobile phones as an educational tool within the classroom'. The influence of the formal curriculum was evident in the way many students justified or explained use of mobile phones, often expressed as how they helped revise for exams, or provide evidence of learning for eportfolio assessment.

A conversation with the School B champion, also a school governor, turned to the role of governors. This extract shows the intricate relationships between teachers, governors, and the leadership team in the context of the wider system.

> A guy from Becta turned up and talked to us about the future of IT and the vision that the Government had regarding use of IT within the curriculum. And he specifically did mention portable devices for students to use. Our chair of governors was there at the time and…he was frustrated because he felt that whilst the Government were telling him where we needed to be as a school, they weren't telling us how to get there and at that point I said that, as a school we were halfway there and that we were using the handheld mobile devices as part of the pilot project with the University. He was a bit amazed…There is so much going on and so much that he didn't know. Throughout the course of our discussions, I said 'With the full support of senior leaders', essentially and, you know, a governor doesn't really need to know that. But yes, I did make him aware that it was with the support of the senior leadership team, as indeed I couldn't do it if it weren't for their support.

Here the layers mentioned are Becta, representing 'the Government', the board of governors, the senior leadership team, and the teachers. This extract raise questions of tacit knowledge, agency and deference that can all be considered as aspects of power.

Agency

The research reported here was driven by particular teachers in each school who generally had a view that the devices could assist their work and students' learning, and they variously related the devices to the push for technology in education, and efficiency goals. The reasons teachers gave for using mobile phones included status as a technology college, a belief in student ownership, perceived benefits of using the same device in social and school life, and that fact that students like mobile phones and know how to use them. In School A the 'champion' was a Science teacher, supported by the Head of Department and the Principal. He explained his rationale for using students' mobile phones in class:

> As a society we need to generate a continuous source of good engineers and scientists and to do that obviously we have to engage with them within secondary school to ensure that numbers are retained at A-level and beyond…I think anything that helps enthuse students with science in the classroom has to be a positive.

He expounded the advantages of spontaneity and efficiency, sending regular reminders to his students by text message (SMS), and using students' mobile phones for calculations, experiments needing stopwatches, and as a photographic record. In School B the project was driven by the ICT coordinator, a former teacher, who in addition to borrowing some smart phones from the University, arranged for sponsorship from a phone company, and said:

> I chose the smart phone above and beyond most of the other units because I didn't want a PDA [Personal Digital Assistant]. I wanted a truly mobile unit with all the other features that it had. I was very keen to promote the idea that students have ownership and then they use them both in their social and their normal school life.

In every school teachers had the support of the hierarchy in the form of the head or leadership team, a point frequently made in School B.

Even at the beginning of the project, students in all schools reported using their phones in classes, mainly in Maths (27%), Science (15%) English (11%) and Geography (11%). However they reported quite low use in ICT classes, which might be explained by the curriculum content, which focuses on software more suited to personal computers. School C had been a designated technology college for seven years and teachers said that their motivation for taking part in the project was influenced by its development plan, yet the students here reported using mobiles phones in fewer subjects than in the other schools.

As students were involved as a result of teacher selection, they displayed differing extents of agency. Two Year 9/10 students in School B were involved in this project, but as they were the only students in the class, they both felt intimidated during lessons, as their use would single them out. They were not confident enough to speak directly with staff on their use, and generally used their phones only when prompted. On the other hand, a Year 13 student interacted with the school's learning platform via her mobile phone, capturing and storing images of her own work and other resources for inspiration. Her teacher could also load material specifically to each student's space, thus assisting personalisation. Design Technology students regularly captured evidence of the development of their models using the camera function, and uploaded this to the learning platform. Throughout the project students and teachers reported a range of uses in class, as summarised in Table 2.

Activity	School
Using stopwatch	A, B, C
Photographing experiments, project resources,	A, B, C
Photographing student work for eportfolios	A, B
Photographing texts/whiteboards for future review	B
Bluetoothing project material between group members	A, B, C
Receiving SMS & email reminders from teachers	A, B
Synchronising calendar/timetable and setting reminders	B
Connecting remotely to school learning platform/email	B
Recording a teacher reading a poem for revision	B
Connecting to the Internet	A, B, C
Creating short narrative movies	A
Downloading and listening to podcasts or music	A, B
Using GPS to identify locations	B
Transferring files between school and home	A,

Table 2. Class use of mobile phones

The types of activities were influenced by the school technology infrastructures (for example, only School B enabled access to a learning platform), and the length of time students used the phones in class, but they did not appear generally to be constrained by the curriculum.

The effect of participation in the project on students in the different schools was evident in the survey responses to the survey questions, shown in Figure 1. The left-hand graph shows attitudes at the start of the project, with three options: mobile phones should be used i) only for emergencies, ii) for specific learning activities or iii) any time in class, while the graph on the right shows attitudes at the end of the project.

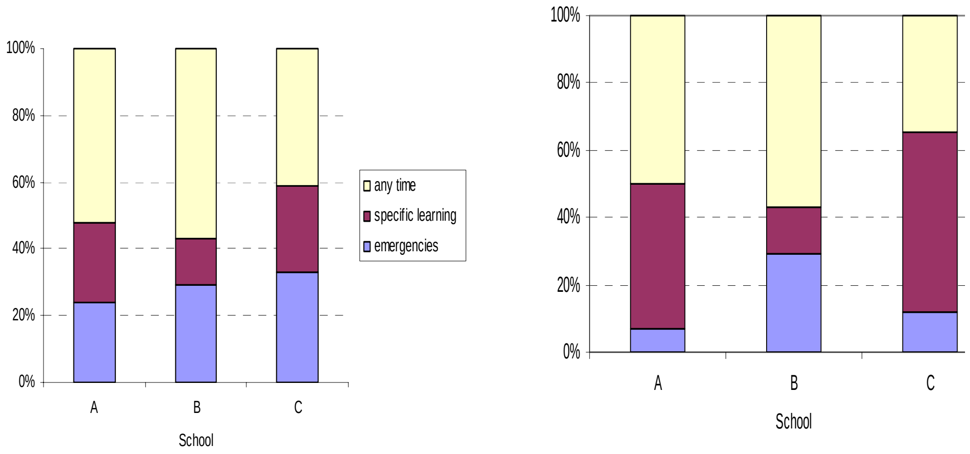

Figure 1. Student attitudes to mobile phone use before and after participation

Figure 1 shows variations in the three schools, but is based on different cohorts over time in School A and B, so must be taken only as indicative. In School A there was a change in students' attitudes to using mobile phones for learning activities instead of only for emergencies. School B showed little change, but already at the outset had a high proportion of students who believed phones should be used at any time. In School C a large increase occurred in the proportion seeing that mobile phones could be used in specific learning activities, while students tended not to suggest 'any time' use.

Teachers who participated in the project saw themselves as learners, and were happy to explore new practices with their students, leading to new awareness. The champion in School B said 'I used to think text messages were a waste of time'. They generally felt that hands-on professional learning was important for them and for others, while student management strategies were also a consideration. A School A teacher captured it clearly:

> A lot of it will depend on the particular school and the ethos within the school. It may not work everywhere and the problem is that as teachers we like to have quite clear boundaries and there is a lot to be said for being always consistent with how you enforce things…You [students] always want to do something that you're not allowed to do and when you're allowed to do it then the novelty disappears.

A group of teachers in School B felt that the most important thing they had learned was that some students who were lacking in confidence were using the units so successfully that they had 'blossomed' both in their social and learning environments and their work ethic had increased almost exponentially. Others on the periphery had mixed reactions, as one student in School B reported:

> My geography teacher said that I'd used it brilliantly and I was always getting things for her as well. When she didn't know a fact I was able to go on the Internet and quickly look it up. I could help her teaching, to quickly look it up...Some of the teachers were quite resistant to being recorded in class, because when I asked my history teacher he said "No. No, I'm not being recorded in class. No."

He went on to analyse issues of control and social practice in terms of teacher resistance, societal attitudes, and classroom management, suggesting that teachers could take control by recording themselves and sending podcasts to students.

A teacher in School A suggested changing the school policy and trying to 're-educate the kids'. However the findings in this paper suggest that changing the policy would be much more difficult than changing student attitudes. Two teachers in conversation in School B suggested teacher development would occur gradually, given awareness of a need, as a drip over time. As technical support and infrastructures also play a part in successful mobile phone use, the attitudes of IT staff need to be taken into account. An interview with a member of technical support staff in School C revealed that although students did the right thing, he could not support future use:

> Because I can't see that there's anything on them that you can't do with something else and be more controlled. Mobile phones are here to stay, obviously, there's not many people who haven't got a mobile phone now, but as a teaching aid I'm not convinced.

On the other hand, parents whose children were involved in this study did not appear to reflect the negativity of the media or some teachers. In School A, students reported that their parents thought it was a good idea, even fun, easier than carrying a camera, and 'it's your phone, if you lose it it's your problem'. A School B student said that at first his parents 'were a bit resistant, but when I explained to them that it was mostly for learning, and the things that I could use it for, they were actually quite happy for me to use it'.

Schools normally provide computer resources for students, often with extensive government funding. Using mobile phones raises the possibility of shifting the cost burden to students and their families, as one teacher raised, adding 'Oh, don't tell the Government that!' The cost of wireless Internet smart phones means that they are not ubiquitous among secondary schools students. However 24/7 use is the desirable option. Therefore cost and ownership go hand in hand as issues to consider.

CONCLUSIONS

In seeking to understand structure and agency in the social practices surrounding mobile phone use in schools, this study found that school policies are not statutory, but local guidelines, indicating and at times reifying the behaviour or procedures decided by the dominant group. This study suggests that this group consists largely of some teachers, with the support of governors. In spite of school heads holding a position in which they operationalise policy, in each case they approved of the use of mobile phones both for this project and on other occasions, both as 'common sense' and positioning their schools as technology leaders. Students tended to be compliant, since they had been socialised into a construction of mobile phones as social, rather than learning tools, and they read the power relations in the school hierarchy. Their attitudes to the use of mobile phones in class easily changed when teachers sanctioned learning uses. The curriculum, except perhaps for that in ICT, does not appear to constrain use. The conclusion is that teachers will be the people who change practice in this regard, and this will result from a shift in attitude. If they see a purpose, they clearly have agency. This study showed that hands-on experience makes a difference to teachers' attitudes, and the negative connotations portrayed in the media were counterbalanced with actual experiences.

While there is a history of large-scale technology implementation in the United Kingdom (such as the introduction of interactive whiteboards), this study makes a case for individual approaches that fit with individual school cultures. If policies are formulated rules (Giddens, 1984) and, as in the examples in this paper, weakly sanctioned, it seems likely that they can be changed locally to reflect emerging social practice, when a tipping point is reached (Gladwell, 2000). Loosely-coupled school systems should enable change to take place without national policy intervention. Reflecting on this study however, it seems that mobile phones act as a substitute for the deeper concerns of teachers, and it is not a 'mobile phone policy' that is required. Teachers are concerned about inappropriate behaviour in school and other contexts, privacy and security of data, including photographs and video clips, distractions in class, and cheating. Therefore these are the real issues of social practice that have a time-space dimension, while mobile phones are a more ephemeral tool. Schools also operate within a larger system that requires them to provide tools to support personalised curricula, raising issues of ownership of computing equipment and access to network connections. In the practice of learning, and given device convergence that means mobile phones contain functionalities of computers, small computers now contain skype phones and personal digital assistants connect to the Internet, the first need for schools is to identify how any devices can help students achieve their goals for learning. Then, appropriate models of ownership will need to be developed, and these may well differ in different contexts.

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The Feasibility of Using Mobile Devices in Nursing Practice Education

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ABSTRACT

This paper focuses on an exploratory evaluation of the use of m-learning in nursing education. We report on Stage 2 of the formative evaluation of a project to integrate mobile learning into the Bachelor of Science Nursing curriculum in a Western Canadian college program. Third year nursing students and instructors used Hewlett Packard iPAQs for five weeks in a practice education course in April - May, 2007. The iPAQs provided WiFi and GPRS wireless capability and were loaded with programs such as Microsoft Office Mobile 6.0 and the 2007 Lippincott Nursing Drug Guide. Our participants found the mobile devices supplied to be easy to learn and comfortable to use. They felt that the devices were readily portable and the screen size sufficient for programs designed for this medium. However, they nonetheless had difficulty using the wireless connectivity afforded by the devices and found that, despite an initial orientation, they did not have time to fully learn the devices in the context of a busy course. We concluded that it was feasible to implement mobile devices in nursing practice education, but that further investigation is needed on the use of m-learning for communication and interactive purposes.

Key Words: Nursing education, practice education, mobile learning, m-learning, FRAME Model

Background

Keegan (2002, 2005) declares that the future of distance education is wireless and notes that there has never been a technology that has penetrated the world with the depth and rapidity of mobile telephony. He claims that the challenge for distance educators is to now develop pedagogical environments for mobile devices. Kukulska-Hulme and Traxler (2005) view mobile technologies as most significantly supporting learning that is more situated, experiential and contextualized within specific domains, as well as the creation and use of more up-to-date and authentic content.

In healthcare, the high acuity and pace of practice in institutional environments, combined with an explosion of knowledge and technology, increasingly requires practitioners to access and process clinical data efficiently by drawing on current resources to support safe care and evidence-informed practice at the point of care. Moreover, the shift of client care to the community requires that the education of health care professionals take place increasingly in this more autonomous and diverse practice environment where resources are not readily accessible, where client acuity is increasing, and where more traditional methods of directly observing and working with students are not as feasible. Addressing these challenges requires new approaches and tools to support the teaching and learning of health care professionals.

The FRAME Model

In our on-going study of m-learning in nursing education (Kenny, Park, Van Neste-Kenny, Burton, & Meiers, in press), we have used the Framework for the Rational Analysis of Mobile Education model (FRAME), (Koole, 2005; in press; Koole & Ally, 2006) to guide our understanding of m-learning. Koole describes m-learning as a process resulting from the convergence of mobile technologies, human learning capacities, and social interaction, from the interaction of the device, learner, and social aspects of learning. The *Device Aspect* describes the physical, technical, and functional components of mobile devices, i.e., the medium through which mobile learners interact and which can have a significant impact on the physical and psychological comfort levels of the users. The *Learner Aspect* refers to the individual learner's cognitive abilities, memory, and prior knowledge, and to those situations and tasks in which a learner needs to succeed. The *Social Aspect* refers to the processes of social interaction and cooperation. Individuals must cooperate to exchange information, acquire knowledge, and sustain cultural practices. The intersections between these three aspects are seen as *Device Usability*, *Social Technology*, and *Interaction Learning*. *Device Usability* relates the characteristics of mobile devices to cognitive tasks and to the effective manipulation and storage of information, while *Social Technology* describes how mobile devices enable communication and collaboration amongst *multiple* individuals and systems. *Interaction Learning* focuses on social interaction. Participation in learning communities and cognitive apprenticeships

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can provide socially based learning environments in which learners can acquire information and negotiate meaning. All of these components then interact to define the m-learning process.

Mobile Learning in Nursing and Nursing Education

Nurses have been using mobile devices during the past decade for many reasons. These include such functions as to keep task lists, as memo pads, as calendar/date books, to access clinical reference material, for e-mail and for Internet access (Cahoon, 2002; Rosenthal, 2003; Stroud et. al., 2005). Newbold (2003) lists such additional potential clinical applications as interdisciplinary consultations, electronic ordering and test results, patient histories, progress notes and assessments, references, protocols, and prescription information, while nursing instructors have used the devices to keep records of student assignments, checklists for completing physical assessments, as a source of point-of-care reference (drug software) and to document student progress on-the-spot (Lehman, 2003). Goldsworthy, Lawrence and Goodman (2006) reported that student nurses showed a significant increase in self-efficacy in their preparation for medication administration while using PDAs and Miller et al (2005) found that students utilizing PDAs had increasing numbers of questions when in the practice setting, as well as a greater recognition of the need to use current resources. Other reasons why nurses recommend PDAs for use in practice include their light weight, their convenience, the decrease in medication errors they afford (as their use is safer than relying on memory), the immensity of the information they make available, and their use to explore options with clients (Davenport, 2004; Park, 2006).

The Relationship between FRAME Model and Research on Mobile Learning in Nursing

Research on health care professionals' use of PDAs tends to focus on the aspect of device usability (e.g., Cahoon, 2002; Newbolt, 2003; Rosenthal, 2003) and shows that they are early adopters of PDAs as content providers. Nurses use mobile devices to access content such as information on drug interactions and for such tasks as sending pharmacy and laboratory requisitions. The ongoing recording of patient information is also facilitated (Cacace, Cinque, Crudele, Iannello & Venditti, 2006; Thomas, Coppola & Feldman, 2001).

The social technology aspect, on the other hand, is the least explored component in the research literature. Stroud, Erkel, and Smith (2005) and Park (2006) both found students mentioned email as the only interactional use of the PDAs. As a result, we conclude from our review of the literature (Kenny et al., in press) that there has been little research on interactional use of PDAs by health care professionals and that the connectivity potential of mobile devices for teaching and learning has not been fully explored. M-learning potentially may afford learners access to immediate and ongoing access to information, peers, and experts who can help them determine the value of information found on both the Internet and in their real-world environments (Koole & Ally, 2006). The research reported in this paper focuses on an initial, exploratory study of these possibilities within the context of nursing practice education.

Methodology

This study was a two stage formative evaluation of the use of mobile devices in Nursing practice education. Stage 1 was a one-on-one trial designed to test the feasibility of the use of the iPAQs with nursing students before their introduction into a real life nursing class. Two instructors and three volunteer students in the final year of a 4 year Baccalaureate Nursing Program at a western Canadian community college participated in this part of the study. The results of Stage 1 are reported in Kenny et al. (in press). This paper reports on the results of Stage 2, in which we conducted a field trial of mobile learning in a real life Nursing practice education course.

Research Setting

Stage 2, then, examined the use of mobile devices in Nursing 357, a nursing practice education course held in April - May, 2007. This course was five weeks in duration and was a consolidating experience held at the end of third year. The class was taught by the two instructors who participated in Stage 1. The study participants consisted of two groups: a mobile learning group of 12 students and a comparison group of 5 students. For the m-learning group, we included all three students in community placements and randomly selected the remaining nine from those students placed in two local hospitals. The remaining students were asked to participate in the comparison group. The m-learning group used the Hewlett-Packard iPAQ Model 6955, which is a combined pocket PC computer, mobile telephone and digital camera, and which provides both WiFi[19] and GPRS[20] wireless capability. The participants were supplied with both those programs included with the iPAQs (Microsoft Office Mobile 6.0, Internet Explorer and Pocket MSN Messenger) and additional software, including the 2007 Lippincott's Nursing Drug Guide, and Davis' Lab and Diagnostic Tests, the Skype audio conferencing program, and Acrobat Reader Mobile, which was loaded onto the devices in advance.

Evaluation Questions

This stage of the study was designed to answer the following questions:

i. Can the use of mobile devices be implemented and sustained in independent nursing practice education settings?

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[19] WiFi networks are short range, high-bandwidth, networks primarily developed for data transmission and use IEEE 802.11 standards.

[20] GPRS, or General Packet Radio Service, is a wide area, mobile data service available to users of Global System for Mobile Communications (GSM) and IS-136 mobile phones. It provides data rates from 56 up to 114 Kbps.

ii. Will nursing students and instructors find the use of mobile devices to be appealing and comfortable in real life instructional settings?
iii. Is the use of mobile devices feasible and practical in nursing practice education settings?

Study Design

Stage 2 was a full field trial. Tessmer (1993) indicates that field trial evaluation should be conducted in actual situations that contain all of the elements of the learning environment. We tested the use of the mobile devices in the actual instructional circumstances under which m-learning would be used with full adoption of this instructional approach, that is, in Nursing 357, a nursing practice education course. Several forms of evaluation data were collected in Stage 2:

1. A pre-study demographics survey,
2. A post survey of student use of the mobile devices in the course,
3. A post survey of comparison group computer activities in the course.
4. Semi-structured interviews with 6 mobile learning group participant students to detail / follow up on survey results. This was a purposive sample to ensure representation of different practice settings and included the three participants in community placements.
5. Cell phone and data download statistics and cost data on faculty and mobile group device usage.

Analysis

The pre-study demographic survey was tallied and descriptive statistics compiled. The interviews were transcribed and coded using AtlasTi© software. Each interview was coded by two research team members independently and then the codes were merged. The codes were next discussed by the research team and consolidated codes were grouped into networks or themes.

Findings

Evaluation Question 1: Can the use of mobile devices be implemented and sustained in independent nursing practice education settings?

Prior knowledge of computing and of mobile devices. The survey data and interviews revealed that most of our participants felt quite comfortable with personal computing. All had owned a personal computer for at least 2 years prior to the study and all used devices with the Microsoft Windows operating system. None reported discomfort with personal computing. Eight students indicated they were somewhat comfortable with computers and 9 reported being very comfortable. Their experience with m-learning, on the other hand, was limited. Thirteen participants owned mobile phones and six owned a PDA or a smart phone. For most of the participants, however, this was their first experience with a PDA – style pocket computer. They all had used MS Windows, MSOffice, and Hotmail on desktop or laptop computers, but not on PDA style devices. They were also aware that there was nursing software for PDAs, but most had not used it.

Despite their lack of direct experience with PDAs, all but two participants reported that they were at least somewhat comfortable with these devices. This was a somewhat curious self rating since their prior experience clearly was only with mobile telephones and, to a lesser extent, digital cameras built into their mobile phones, rather than with the functions and software provided in the HP iPAQs (See Table 1).

Feature	None	Beginner	Competent	Experienced
Telephone	2	2	4	7
Photography	5	3	5	2
Email	7	3	3	2
Internet	6	5	2	2
Text Messaging	6	1	6	2
Audio Messaging	9	2	2	2
Word Processing	9	3	1	2
Spreadsheet	10	3	1	1
Database	10	3	1	1
Nursing Software	9	2	3	1

N = 15. Two participants did not complete this part of the survey.

Table 1. Prior Expertise with Mobile Devices

The interviews, however, revealed that this comfort was largely based on their experience with desktop computing rather than as a result of the applications on mobile devices specifically. Terrie's[21] response exemplifies this:

> Well, I have a fee… being comfortable on a computer is a good start, because… to me it's a little version of a computer, right? Especially with the Windows program and such. If you're comfortable on a computer and how to

[21] Pseudonyms are used in place of participants' actual names.

search the internet… different addresses and just how to do a basic search… you would need that sort of knowledge.

Learning the Mobile Device Features

It was not a simple task for our participants to learn all the features available on these devices. The mobile devices contained a wide range of software and provided our participants with a variety of built-in features. They had access to three different keyboards: a) a touch screen keyboard, b) a thumbing keyboard, and c) a near full sized, detachable, folding keyboard. The devices also allowed the transcription of hand writing (using the stylus on the touch screen) to text. In addition, our participants could use either WiFi hotspots or GPRS wireless connectivity to send email, browse the Internet, or use an audio conferencing program such as Pocket MSN Messenger or Skype. For the study, the iPAQs were set up with local service GPRS connectivity and WiFi was available both on campus and in spots around the community (e.g., coffee shops) as well as the home networks of some participants.

The mobile learning group was provided with a two hour orientation to the devices at the beginning of the study. They were directly introduced to a number of these features and provided with time to practice under supervision. Features taught during the orientation were: a) use of both the touch and thumbing keyboards, b) cursive to text transcription, c) how to enable wireless connectivity (WiFi and GPRS) for email and Internet browsing, d) use of the nursing drug and lab values software, and e) use of text and audio messaging (e.g., Skype). Any further instruction after the orientation was done on individual request to the instructors. No technical support was provided by the community college. In fact, our interviewees indicated that they felt no need for technical support beyond that provided by the instructors nor had they required more training. Instead, they would refer to the user manual provided or would figure out how to use the application on their own. A comment from May exemplified this attitude:

> 'Mmmm. Well the orientation session was really helpful. Uh… in learning how to use it. That basically answered pretty much all of my questions on… on learning to use the device. Other things… I didn't really encounter too many problems. Other things I just kind of figured out from trial and error…'

Table 2 reports the mobile group participants' views from the post survey on the ease of learning the various mobile applications. Curiously, while participants largely reported that the mobile applications were easy to learn, this viewpoint was not necessarily based on their direct experience with the mobile applications beyond the orientation as the usage data showed that participants engaged in minimal use of GPRS connectivity to download data. Only two of the twelve mobile group members downloaded more than 10 MB of data over the five weeks. The rest used 2 MB or less and most (eight students) did not use this feature at all. This would imply that they did not use the devices to access the Internet or send email while they were in their practice experiences since neither hospital and none of the other placements were they were assigned had WiFi hotspots. One hospital did have WiFi in the cafeteria, but not on the wards. GPRS connectivity, therefore, would have been the most likely way for them to use these applications in practice.

Application	Very Difficult	Difficult	Relatively easy	Easy
Telephone	0	0	4	8
Email	1	0	5	5
Browsing Internet	0	0	6	6
Text messaging	2	0	7	3
Audio messaging	3	4	4	1
Pocket Word	1	1	4	6
Pocket Excel	2	1	4	4
Drug software	0	0	5	7
Lab software	0	1	5	6
Total	9	7	44	46

Table 2. ***Ease or difficulty in learning the mobile applications.***

When asked in the interviews about how well they learned to use the mobile devices, participants raised two main concerns that explained why at least some of the participants may not have learned to use them well. First, most students found that, because of the intensity of the one month practice experience, they lacked sufficient time to focus on learning the devices and, therefore, tended to not use them as much as they might otherwise have done. It was a voluntary, not required, learning activity. Joan explained this issue:

> 'I thought it was really very neat and I.. I feel a little bit bad that only in the last couple of weeks just started getting in to it more. I think I was really quite overwhelmed with everything else getting started and it was really busy where I was, so I wasn't utilizing it as much, so I had um… not remembered everything that I had sort of learned, so it took a little bit more to start learning things. But the last couple of weeks I really started using it a lot more and started to enjoy… and not feel afraid of it.'

The second issue was that the students did not own the devices. They felt less inclined as a result to invest time in learning to use them and also were afraid to damage what they viewed as expensive devices. Joan also noted that:

‘I think a longer period of time would have lended itself well… just to the fact that you needed that… okay, like putting everything into the calendar, for instance. Right, well you spend this time loading it all in and it’s only for this amount of time and as it was, you know, our time was very, very limited, short with things. You know, in terms of assignments and clinical and doing extra things and...’

Evaluation Question 2: Will nursing students and instructors find the use of mobile devices to be appealing and comfortable in real life instructional settings?

Ease of Use

Despite the apparent complexity of the devices, especially the number of features to learn, our participants uniformly claimed that these devices were easy to learn and easy to master overall. In addition to the orientation, our respondents found that they only required a few hours learning on their own afterwards to become comfortable with the use of the iPAQs. In the post survey, when asked to indicate how long it took them to learn various applications, nearly 78% of all responses from mobile group participants were that it that it took then one hour or less.

Of the various programs on the iPAQs, our participants found the Nursing software to be most user-friendly and reported this to be the software they used most in the trial. They also found Pocket Word simple to use since it was a reduced version of the desktop computer version. When asked which programs she found easiest to use, Alice commented:

Alice: ‘Both. Drug guide, the drug manual and the… um, procedures…’

Interviewer: ‘Mmhmm.’

Alice: ‘…the procedures. And the Microsoft Word was actually really easy to create a Word document. And I’m technologically challenged, so if I can do it, anyone can do it! <laughs>’

Portability. One of the most pervasive arguments for mobile learning is the perceived ready portability of mobile devices. Our participants generally agreed that the iPAQs were portable, but they tended to find it somewhat heavy for carrying attached to their uniforms. Joan’s comment is representative of how the devices were carried:

‘It was fairly portable. I mean, because I had my big bag with me and it also fit in my purse too, so I could actually take it with the… uh… if I was leaving the office and I didn’t take my big school bag I could pop it in my purse or take it with me when we were going to see clients or clipped on too… most of my of my clothing it clipped on okay, but if I was wearing a skirt that was a little bit thinner and it would pull it down a little bit right? I would feel uncomfortable wearing it, it was better when I had jeans on. Like, something that was a little bit more heavier weight to it’

Size of the screen. Kukulska-Hulme and Traxler (2005) considered that mobile technologies might be most useful to support learning that is more situated. However, this implies that users can comfortably and effectively use their mobile devices for the specific task at hand. When asked about the screen size of the devices, our respondents had varying opinions, but tended to point out that it was too small for many tasks they needed to carry out. They found it acceptable for purposes such as consulting the drug reference program, but not for browsing web sites or reading or creating word processing documents where they found themselves having to scroll both vertically and horizontally through the document. Alice, for example, commented:

‘Um… I found that it was great, like as far as looking up, um, the drugs or the procedures or IV… procedures or what not. But um, for Word documents, I found, without the keyboard, the screen… it was very difficult with the small screen to type an actual full Word document’

Barriers to use As was the case in Stage 1, the feature that posed the most difficulty for participants was wireless connectivity. Despite orientation to this feature, few of our participants were able to make the GPRS data connection work when using the devices on their own and they were also unable to use wireless connectivity in the hospital. Local hospitals in our region still tend not to allow the use of wireless devices on the wards for fear of causing medical equipment to malfunction and, therefore, neither supply WIFI connectivity nor allow the use of GPRS devices a the bedside. Terrie commented on the inconvenience and her resultant choice not to use her mobile device connectivity in practice:

Terrie: ‘I couldn’t have the Internet on in my practice for some reason… I just left it off because I didn’t know what the issues were… with that, and I… and I couldn’t access... I tried to get on to it at the [local area] hospital, I couldn’t get internet on the… what’s it? Hi-Fi?’

Interviewer: ‘Wi-Fi’

Terrie: ‘Wi-Fi, yeah. I couldn’t pick it up on my… well on my floor. I could in the cafeteria, but… so I didn’t really use internet up there a lot’

During Stage 1 trials, the instructors and research team discovered one other barrier that promised to seriously impact Stage 2 of our study, but were unable to remedy the problem in time. Participants were not able to use the iPAQs to access the WebCT course website that was the main vehicle for communications and for sharing of resources in the nursing practice course. The issue appeared to be with Java scripting and, at the time of writing, the problem still has not yet been resolved, which will necessitate a switch to the Moodle LMS, which can be accessed by mobile devices. This highlights the need for the use of learning management systems and web sites that have been designed specifically for mobile use (e.g., Google Mobile). Joan's comment highlighted the problem:

> 'And I guess it would have made it better had we been able to access WebCT, because that's where I was sending all my documents from home, right?'

Evaluation Question 3: Is the use of mobile devices feasible and practical in nursing practice education settings?

Our participants expressed mixed feelings about whether or not they found the use of these mobile devices in this specific practice experience to be useful. This course was of short duration (five weeks) and the students were quite busy. Table 3 reports the mobile group post survey responses pertaining to the usefulness of the mobile applications in their practice experiences and shows that students were nearly evenly split in their assessment. The applications rated most useful were, in descending order, the Nursing programs (drug reference and lab values), the mobile telephone and Pocket MSWord (tied for second), email (third) and browsing the Internet (fourth).

Application	Useless	Rarely Useful	Sometimes Useful	Frequently Useful
Telephone	2	3	2	5
Email	3	2	5	2
Browsing Internet	2	4	1	5
Text messaging	4	3	3	2
Audio messaging	8	3	1	0
Pocket Word	2	3	3	4
Pocket Excel	7	2	2	0
Nursing software	1	2	4	5
Total	29	22	21	23

Table 3. ***Usefulness for completing course learning activities***

When asked about their specific use of the mobile applications, eight mobile group participants indicated that they used the Nursing programs at the bedside to verify information at least five times and seven of them used these programs more than ten times during their practice experience. However, only two participants reported using this information for patient teaching and only one did so more than five times. The participants also indicated in the interviews that they found the drug reference and lab values software the most useful application. When asked how she might use mobile devices in her overall Nursing education, Alice commented:

> 'Um… well for anything that I've just mentioned, for… looking up… Um the biggest thing for any student, I would say, is looking up medications that you're unfamiliar with. Looking at the weights for, um, complex procedures like blood transfusions, that's right at your finger tips and it's accurate and up to date. Um, plasma transfusions, um, like compatibility of IV fluids and stuff, um…'

This response highlights the fact that nine of the twelve mobile group members were in hospital placements, while only three were in community placements. Those students in the hospitals would have been much more likely to have to given medications on a daily basis and, therefore, more inclined to verify drug information.

Nurses' use of PDAs to reference content, however, is already well established in the research as discussed above. Our team was most interested in the use of mobile devices to foster more active communications between the students and their instructors when out in the field as well as to improve communication among students. We thought that nursing students would feel more need for communication when were out in community placements such as clinics and even patients' homes, than when in hospitals. When asked if they used the mobile devices for communicating with instructors or fellow students, our participants indicated that, for the most part, they did not (See Table 4).

The figures in parentheses in Table 4 show the responses of the three students in community placements. Only one of the three actively used the phone and text messaging to communicate with fellow students, which would imply that these students did not need to communicate any more regularly than students in hospital placements. In their interviews, these participants reaffirmed that they did not feel the need for frequent communication, but the reason surprised our instructors and highlighted a problem with these placements. Students in the community placements tended to be placed in passive, observational roles, rather than to be engaged in direct nursing care themselves. As a result, they were not involved in making decisions about the care of patients and, therefore, felt no need to seek the support and advice of their instructors or fellow students. A comment by Joan highlights this circumstance:

> 'I'm sure… I mean I can totally see in the hospital how it would be really very valuable having that right beside you at the bedside. I mean I guess I don't see it as valuable because I didn't need to access information right on the spot and use it when I was in clients' home when we went on home visits and stuff like that. Because the information that they give people, it's all in pre-packaged, kind of a package that we give people for home visits, for baby visits and stuff. And anything that we're needing to record there, it has their preset type of sheet that they have. '

	Never	1- 2 times	3 - 4 times	5- 6 times	> 10 times
Communicating with other students					
Telephone	5 (1)	4 (1)	0	1	2 (1)
Email	9 (2)	1 (1)	0	1	1
Text messaging	7 (1)	3 (2)	0	1	1
Audio messaging	12 (3)	0	0	0	0
Total	33	8	0	3	4
Percentage	68.8	16.7	0.0	6.3	8.3
Communicating with instructors					
Telephone	4	6 (2)	1	0	1 (1)
Email	4 (1)	6 (1)	1 (1)	1	0
Text messaging	2	5 (1)	3 (1)	1	1 (1)
Audio messaging	12 (3)	0	0	0	0
Total	22	17	5	2	2
Percentage	45.8	35.4	10.4	4.2	4.2

Table 4. *Usefulness for completing course learning activities*

Conclusions

In past work (Kenny et al., in press), we have pointed out that nursing care is moving to the community where client complexity and acuity is increasing and where up-to-date information at the point-of-care is critically needed to support practice. As a result, the delivery of nursing education requires physical mobility throughout the community and does not lend itself to more traditional direct teaching supervision models. The purpose of Stage 2 of this study was to test the use of m-learning to support teaching and learning interactions in this context, that is, in a real life nursing education class. The answers to our evaluation questions tended to confirm what we had learned in Stage 1.

We asked if m-learning can be implemented and sustained in independent nursing practice education settings. This question is closely related to the second evaluation question concerning the appeal and comfortable use of mobile devices by nursing students and instructors and to the issue of ease of use. The results again show that our participants believed that the use of mobile devices in practice education is both possible and desirable. They uniformly reported they were comfortable with personal computing in general and with mobile devices specifically. Despite having to learn a number of features to use the iPAQs effectively, they reported them to be easy to learn and master overall. Our participants particularly found the nursing software (drug reference and lab values) and familiar programs such as Pocket Word simple to learn and to use at the point of care. They also found the devices to be readily portable and the screen sufficiently large for many uses. However, despite direct teaching and practice of the feature during the orientation, few of our students were able to make effective use of the GPRS data connectivity when using the devices on their own. It is likely that a more thorough orientation and more practice of these features would be needed before students will feel comfortable with the interactional uses of mobile devices.

This failure to fully learn and use the devices is likely also related to the pilot nature of the experience. Even though they thought the iPAQs did not take long to learn, when faced with an intensive, one-month, practice experience, the students found that they did not have sufficient time to focus on learning the devices and, therefore, tended to not use them fully in their learning. It was a voluntary, not required, learning activity, and, therefore, overall, not a full test of m-learning in this context. This concern was compounded by the fact that the devices did not belong to the students nor did they have them for an extended period of time. It is doubtful, therefore, that they wished to devote the time and energy into fully integrating them into their learning. Finally, we wished to determine if m-learning was useful in nursing practice education settings. Our results appear to indicate that m-learning is useful in this context, at least to a degree. Our participants referred to the Nursing software as the most useful feature of the mobile devices for their nursing practice experiences. They found the devices convenient for immediate reference and easy to access when needed. They also thought that the devices were sufficiently portable for use in practice, although a bit heavy to carry in a nursing uniform. They judged screen size to be suitable for programs, like the nursing software, designed for mobile use, but not for such purposes as browsing a full web site on the Internet or creating a full word processing document.

However, our participants did not find the mobile devices useful for communication purposes despite including a mobile phone. They encountered a hospital culture and policies that precluded the use of wireless devices in those settings and had difficulty with connectivity in any case. The most serious impediment was the inability to use the iPAQs to access the course website. This was the main vehicle for both accessing course documents and for posting messages to the instructors and other students. It will be necessary to resolve this problem if m-learning is to be effectively implemented in future in this or related practice education courses.In conclusion, Stage 2 of our study confirmed that the use of m-learning, at least with mobile devices providing the breadth of features afforded by the HP iPAQ, is feasible in actual nursing practice education settings. At a minimum, mobile devices have the potential to be very effective in allowing students and instructors ready access to resources at the point-of-care. We have not yet been able to determine if the interactive and communication uses of mobile devices are can be used in this setting. This needs to be more thoroughly investigated in future investigations.

Future Research

The voluntary nature of the learning activity in this pilot study highlights the need for a more extensive trial of m-learning in which the use of mobile devices is an integral part of the course. The authors are now planning a study of Mlearning in a Nursing practice education course to be offered over a thirteen week period in the winter, 2009, semester. Instructors and students will first be oriented to the devices and asked to practice the specific features of the devices around campus and the community for two months (November – December, 2008) before the course begins. The use of the mobile devices in the course will be compulsory in order to support the learning of nursing technology learning skills specified among the Nursing program learning outcomes. Students will be asked to search for information through the use of reference software on the mobile devices and on the Internet and to communicate with faculty and other students through email, web-based discussions and voice over internet protocol (VOIP) audio technology. In addition, while we continue to believe that mobile technology can facilitate learning in this context by assisting instructor – student and student – student communication, we feel that we need stronger theoretical support for this conviction. This has led us to consider the application of the Community of Inquiry (COI) model (Garrison, Anderson, & Archer, 2001) to m-learning in this context, to how improved communication might help to build and maintain learning community by increasing learners' cognitive presence and teaching presence. We also believe that the COI and FRAME (Koole, 2006; in press) models have considerable overlap, with the latter likely describing a subset of the former specific to m-learning, and intend to investigate further this relationship.

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Learning for life: Implementing a Medication Management Module to Support Learning Among Adolescent Diabetics

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ABSTRACT

Many people suffer from potentially dangerous diseases. This paper is concerned with diabetes, in particular for cases involving young patients. Rationally, of course, most patients agree that they worry about the risk of falling ill in both the long and the short term. Hence, they are willing, in principle, to change their behaviour according to medical stipulations. In the case of diabetes, this comprises measuring the level of glucose in the blood, observing a strict diet and exercising regularly. In practice, however, this turns out to be difficult for many patients. Making this a classical case of learning, the link from theory (knowing the disease) onto practice (controlling the disease) needs to be strengthened. We propose a tool that may contribute to this, by explicating the dialogue between the learner and the "text," which is an aggregate of medical expertise, parental supervision, personal experiences and the adaptation to the social and situated context. The tool is based on an explicit learning model, but the purpose is not one of promoting this particular model before the alternatives. The aim of this paper is to show how the tool can accommodate such models in general, and be used to further investigate their effectiveness in an empirical fashion. The model does, on the other hand, lend itself clearly to explicate exactly one mobile and collaborative form of learning that may be required to accommodate the normal lifestyle of adolescents with diabetes.

Author Keywords
Mobility, adolescence, diabetics, learning, human computer interaction, quality of life

INTRODUCTION

Diabetes is a disease where the body's own production of the insulin has stopped or been greatly reduced. Insulin is necessary to allow cells to utilize sugar transported around the body through the blood. Without insulin, the blood sugar (glucose) level will continue to increase, causing various medical problems, and in the end be fatal to the patient. The treatment of diabetes consists of monitoring actual blood sugar level, and injecting insulin (using a syringe) several times a day. Typically, a diabetic will inject insulin before all meals as well as once or twice each day using a "long-term" type of insulin that provides a base insulin depot in the body. The amount of insulin that is injected is critical. Administration depends on establishing a "mental model" of the relationship between activity, food and medication, which is based on experience. Assessing the effect of food on blood sugar is non-trivial because different types of food contain different amounts of sugar and is transformed into blood sugar at very different rates.

A common objective will be to develop procedures that combine medical data, which are necessary or useful to adjust the dosage of drugs that comprise the cure, and patient parameters more generally. Different parameters will be requested depending on the illness, bearing in mind that we want our approach to be valid for other chronic diseases as well. Some of the parameters will be truly context-dependent, however, and their range and significance will in relevance and number vastly surpass the context-dependent data that we have seen alluded to for horizontal applications (Schmidt, Beigl et al. 1999), e.g., blood sugar level and time of measurement, food intake and time of eating, physical exercise as well as time period and exercise level, heart rate, blood pressure and body temperature, cross-medication, even with non-prescription drugs sleeping pattern, weight (loss) and body composition, etc. In the specification below, which illustrates our approach, the first three of these are explicated.

There are numerous challenges associated with the care of children and adolescents with diabetes. For instance, insulin doses may not simply be calculated on the basis of body weight, since individuals respond differently to hypoglycemic events (too low blood sugar) due to their variable hormone responses, which are different from adults (Silverstein, Klingensmith et al. 2005). The fear of hypoglycemia adds to the social and psychological challenges associated with the disease, and may cause less strict metabolic control (Ryan and Becker 1999). Erring on the "safe side," however, may lead to continually excessive levels of blood sugar, which is a cause of eyesight and kidney failure, as well as other complications in the long term (Harvey and Allagoa 2004).

In terms of self-managing the disease, medial research presents results that are ominous, indeed:

"Health providers and family members may underestimate adolescents' difficulty managing hypo- and hyperglycemia appropriately. The presence of parental supervision does not ensure an appropriate response; parents may be particularly misinformed about the management of hyperglycemia (Johnson, Perwien et al. 2000, p. 171)."

The practice does not improve particularly as the patient grows older (Balfe 2007), which clearly indicates the need for a more deeply rooted approach to trying to change of behaviour through learning. The potential of mobile learning in such situations is great, as we know from other domains (Connor, Peter et al. 2006). Continuous and timely responses to challenges in the patients' everyday life may be better suited and more convincing than traditional and theoretical approaches to teaching the patient about the management of diabetes and its consequences.

The research objective addressed in this paper is to explore a novel approach to technological support for learning for diabetes patients, by allowing them to explore and check the "theoretical" implication of their "lived" experiences. In our initial implementation, this is conceived as implementing a graphical user interface on top of a set of mathematical objects and equations, which enable advanced theorem checking by simple means.

RELATED RESEARCH

There have been several attempts made previously to develop mobile technology in aid of patients with diabetes. Some are still quite visionary, in terms of the advanced sensor technology that will be required in order for the patient to actually do the measuring themselves whilst mobile (Mathews and Butler 2005). Other are already functional in an experimental setting, at least to the extent that they can be part of an empirical assessment (Gammon, Årsand et al. 2005). Such systems all seem to have in common, however, that they are made monitor or predict future blood sugar levels as exactly as possible using a compilation of data collected explicitly by the patient.

There has been much work done previously in the area of insulin-dosage calculations algorithmically (Pacini and Bergman 1986). Pacini and Bergman use a model that they call the minimal model (MINMOD) to evaluate the metabolic control of glucose. The problem for our objectives of supporting children is that the input variables do not make sense at all to the patient, and even if they did, they would not be able to collect the data.

Islam et al. have expanded the minimal model with additional equations to implement an algorithm, which is still relatively simple, but comprises even more variables that have to be determined by professional doctors (Islam, Leech et al. 2007). However, some of the insulin sensitivity parameters can also be defined by studying computer simulated glucose profiles and this is an opportunity that needs to be considered. Another algorithm proposed by Fisher, is more adapted to a situation such as ours (Fisher 1991). It is still based, however, on a much too theoretical analysis of the control of blood glucose level and the interaction between the glucose and insulin. It is based on the presence of three plasma glucose samples and although the author acknowledges that the meals are really important for predicting the glucose level, it does not pragmatically consider what sort of food a diabetic is eating. Without knowing (by heart) the glycemic index of a composite meal, which is almost impossible to do manually even if the table of glycemic indices for each ingredient were available, it would be difficult to give a prediction of the individual response.

Ubiquitous monitoring and control of glucose levels and insulin dosages seems to ideal for this condition, and intuitively fruitful, but the observable effects are actually usually quite negligible (Kollmann, Riedl et al. 2007). The results may point in the right direction, but the reduction in average blood glucose levels is not yet found to be statistically significant (Farmer, Gibson et al. 2005). On the other hand, taking a wider perspective comprising motivation factors, have been found to improve the self-management, e.g., in one case of embedding it in a game context (Kumar, Wentzell et al. 2004).

Based on the reasoning above, we have decided to look at the administration and management of enduring medical conditions in a mobile learning perspective. The need to develop a specific curriculum for diabetes patients, has previously been recognized (Knowles, Waller et al. 2006). Previous work also exists, which has attempted to make this curriculum ubiquitously available as an instrument of learning as well as intervention (von Sengbusch, Muller-Godeffroy et al. 2006). This experiment uniformly produced encouraging and statistically significant improvements in levels of glucoses, competencies and perceived quality of life.

Endeavours such as the one described above, may be seen as excessively resource consuming, however, since they involve making an ambulant team of human experts available to the patients and their families. Our aim is different, inasmuch as we seek to develop continuously available mechanisms, which will allow for *explorative learning from patient-specific and context-aware simulations of the insulin-glucose reaction*. Instead of human expertise, we want to experiment with the facilitation of direct interaction with a computer simulation. We see this as a "boundary object (Gasson 2005)," which may mediate and translate the requirements, requests and responses between patients, parents, carers and medical expertise.

Recognizing the need to support learning in order to change behaviour, rather than expecting intervention to come straightforwardly from the patient's exposure to one prediction, is an important novel aspect of the project that is described in this paper. Another, which is related, is that instead of making one prediction, which is as exact as possible, *we encourage the user to explore the complete state space on the basis of more easily compiled and approximate input.* Thus is can more easily be carried out, which will in itself, we hope encourage adoption of the system.

Hence, a technological aid is proposed below, in order to make it easier to collect and compile the necessary data. Taking the theoretically informed approach of designing intervention by a so-called “boundary-object”, we hope to find exactly the combination of aspects that optimized behavioural change (observable learning), whilst minimizing the need for complicated measuring regimes.

IMPLEMENTING A BOUNDARY OBJECT

It seems clear that in order to work properly under the conditions that we have outlined above, a device needs to satisfy several requirements. It needs to be robust and easy to use. It has to be sufficiently fast and power efficient. However, we need to go beyond that in order to arrive at a solution that will work for many diverse groups, and hostile and barren conditions in ecological as well as social terms, and can tie together the concerns of multifarious user groups, such as the parents of a kid with diabetes on one hand, and his friends on the other.

Dedicated devices, which serve specialist-functions, are of course one category of medical equipment that we need to look at, but considering that we are targeting children, this cannot be the limit of our scope. We need to look at the opportunities that exist to integrate heterogeneous devices in order to increase the capacity of cell phone-based healthcare solutions. Therefore we are also going to try to “make medical” much simpler and more available equipment, such as sports’ heart-rate monitors, by inputting their data to the mobile phone application that we propose to develop. Such devices are precise (Treiber, Musante et al. 1989), robust and readily available where more advanced medical apparatus is not.

For the reasons sketched above, we have looked at the notion of a *boundary object* as one way of informing the design of a tool that can compile and enforce a sufficiently strict administrative regime for medical cure adherence. For now, we are going to keep our scope to the harnessing of diabetes with insulin, with particular concern for children since they are less likely to keep track of nutrition, level of activity and insulin dosages themselves.

In previous IS (Information Systems) literature, the notion of boundary objects has had mainly analytical purchase (Star and Griesemer 1989). Therefore, it is a novel contribution of this paper to draw inferences from the usage of the concept for design purposes. There is very little literature on boundary objects as a design component, except “after-the-fact” as one discovers the role such objects have come to play (Henderson 1991). Instead, what we are going to try to do in this paper is to use it as a proactive means of eliciting the design ideas (rather than only mediating them).

The problem that we face in designing a smart tool for our purposes is similar to the one described by Star and Griesemer (1989), in particular because the internalization of the algorithm, which models insulin’s role in the metabolism, e.g., is such an integral part to actually using it. Learning and motivation goes hand in hand, and the boundary object as a perspective on knowledge therefore becomes very useful.

“The creation of scientific knowledge depends on communication as well as on creating new findings. But because these new objects and methods mean different things in different worlds, actors are faced with the task of reconciling these meanings if they wish to cooperate (Star and Griesemer 1989)“

In the terminology of Star and Griesemer, actors inhibit different social worlds, and when they encounter the knowledge interest of parties “from elsewhere” they re-interpret their agenda to fit better with their own. They then try to control action, which is related to the agenda through the object. This is the process of *translation*. As a concept, it fits with our selected domain, which is populated by parents, doctors and children with diabetes. Doctors need to treat many patients efficiently, and look twice only at the exceptional situations. The parents will seek stability and predictability for all family members, while the average kid with diabetes is more likely to want to live life just like his or her friends. Doctors and parents can use *coercion* to maintain the dominant perspective of their own interpretation of the situation (Gasson 2005), but this option is generally quite limited. In general, the dominant “gatekeeper” or any given “obligatory point of passage” must take into account the interests of all parties. In the next paragraphs we are going to outline “the design of a gatekeeper” by means of a boundary object.

A boundary object is an analytical conceptualization of phenomena that “inhibit several intersecting social worlds (Star and Griesemer 1989). Boundary objects cannot be static or standardized, in the sense that there must be room for them to fill different informational needs in different social worlds. The have to be similar enough to be recognizable as a means of translation across social worlds, however, and

“The creation and management of boundary objects is a key process in developing and maintaining coherence across intersection social worlds (Star and Griesemer 1989).”

We want to focus on the learning aspects. We want to think about it in terms of simple parameters, which can be estimated or measured relatively accurately by the patient. We start with levels of activity, along a scale of perceived exertion/effort. Next we want to include a measure of the blood sugar levels, which is absolutely essential for a sufficiently precise administration of insulin. Finally, the nutritional components have to be assessed, e.g., by breaking down by their glycemic indices the components of meals to help the patient anticipate which levels of activity or insulin dosages may become necessary soon. The task is now to make a model with which interaction can be accurately modelled, and then see if it can be implemented to satisfy the requirements of a boundary object.

Our proposal is to make an executable specification, which we have called CATLA (Computerized Aid for Therapeutic Learning in Action), as the first step in the project. We use the declarative programming language Maude (http://maude.cs.uiuc.edu/). The detailed characteristics of the language are outside the scope of this paper), and we focus only on the so-called *rewriting* rules. Consider, for instance, the rule labeled `[activity ]`, which emulates a change in the activity level of the patient and generates an auxiliary message about it to the rest of the system, which can then respond appropriately.

We have specified a module, which (edited for readability) looks like the following:

```
mod CATLA is
     ***( Declarations and help functions removed )

     eq init = < 'steinar : Patient | diabetesType: II,inMsgBuffer: nil, outMsgBuffer: nil,
     currentSugar: low, currentActivity: low, currentFood: mid >
     < 'catlasim : SimPick | splist: high ++ high ++ low ++ mid ++ mid ++ mid > .
         --- twice as likely to get high than low, etc., for easy simu only
     ***(Variable declarations removed )

      rl [ sugar ] :
        ***( Similar, but simpler than the one below )
      .

      rl [ activity ] :
        < PATIENT : Patient | diabetesType: DT,
          inMsgBuffer: IMB, outMsgBuffer: OMB,
          currentSugar: CS, currentActivity: CA, currentFood: CF >
         < SIMPICK : SimPick | splist: SPLSET ++ METRIC ++ SPLSET' >
            =>
        < PATIENT : Patient | diabetesType: DT,
          inMsgBuffer: IMB, outMsgBuffer: OMB,
          currentSugar: CS, currentActivity: METRIC, currentFood: CF >
          < SIMPICK : SimPick | splist: SPLSET ++ METRIC ++ SPLSET' >
          msg PATIENT changed(CA, METRIC) activity
      .

      rl [ sugar ] :
           ***( Similar, but simpler than the one above )
      .

       rl [ sugar-too-low ] :
        < PATIENT : Patient | diabetesType: DT,
          inMsgBuffer: IMB, outMsgBuffer: OMB,
          currentSugar: low, currentActivity: CA, currentFood: CF >
          =>
          ( msg PATIENT increase food )
          < PATIENT : Patient | diabetesType: DT, inMsgBuffer: IMB,
          outMsgBuffer: OMB,
          currentSugar: low, currentActivity: CA, currentFood: CF >
       .

       rl [ activity-increasing ] :
          ( msg PATIENT increased activity )
        < PATIENT : Patient | diabetesType: DT,
          inMsgBuffer: IMB, outMsgBuffer: OMB,
          currentSugar: low, currentActivity: CA, currentFood: CF >
          =>
          ( msg PATIENT increase food )
             < PATIENT : Patient | diabetesType: DT, inMsgBuffer: IMB,
             outMsgBuffer: OMB,currentSugar: low, currentActivity: CA,
             currentFood: CF >
       .
endm
```

For the purpose of illustration in this paper, the two main rewriting rules are `[ sugar-too-low ]` and `[ activity-increasing ]`. The former makes sure that a patient *always* is told to increase his food intake (which may mean taking pure sugar or fruit juice to acutely treat a situation which comprises dangerously low blood sugar level). The latter makes sure that we simulate the same instruction given to a patient as a result of self-reporting that the level of activity is increasing. The outcome is similar, but the causes are different. We can then run a simulation asking the Maude interpreter to find a state in which the patient was instructed to take in more food. The interpreter will according to the specified criteria search the entire state space (if it is finite), and list the number of matching states that we asked for.

```
search in CATLA : init =>* SW:SmallWorld msg P:Qid increase food .

Solution 1 (state 8)
```

```
states: 9  rewrites: 162 in 0ms cpu (0ms real) (~ rewrites/second)
SW:SmallWorld --> < 'catlasim : SimPick | splist: high ++ high ++ low ++ mid ++
    mid ++ mid >
< 'steinar : Patient | diabetesType: II,inMsgBuffer: nil,
     outMsgBuffer: nil
     ,currentSugar: low,currentActivity: low,currentFood: mid >
P:Qid --> 'steinar
Maude> show path labels 8 .
sugar-too-low
```

Showing the path which lead to the state concludes that the reason was that the blood sugar level had dropped too low.

The current implementation is much to rudimentary to be used as an exact vehicle of future blood sugar level prediction. At the same time it is a far too mathematical and complex for any patient to be able to relate to. It is, we admit, the mathematical qualities of the object, which on the other hand makes model checking and exploration possible that also makes it pretty useless in practice. Arbitrarily exact and complex models may of course be implemented, which is encouraging in terms of future work and prototyping for actual patients, but in terms of this being a “boundary object”, which can be internalized and used by these patients, that will only exacerbate the situation. A better user interface is obviously needed. The next section clarifies this part of the system, in order to support its aggregation into a proper boundary object.

THE MODEL

In order to structure the user interface, this paper is inspired by the notion of a “learning model”. The intention is not to enforce learning according to the model, which we have no reason to believe would be more efficient than any other model of a similar kind. However, the case gives ample opportunities to observe an operation pattern as it can be logged during use. This means that the model can be empirically assessed and improved throughout the project. As such it may be seen simply as a hypothesis about how the “learning for life” scenario through the user interface, conceivably may be presented. The top levels of the model can be illustrated by the figure below (Soller 2001):

The collaborative learning process

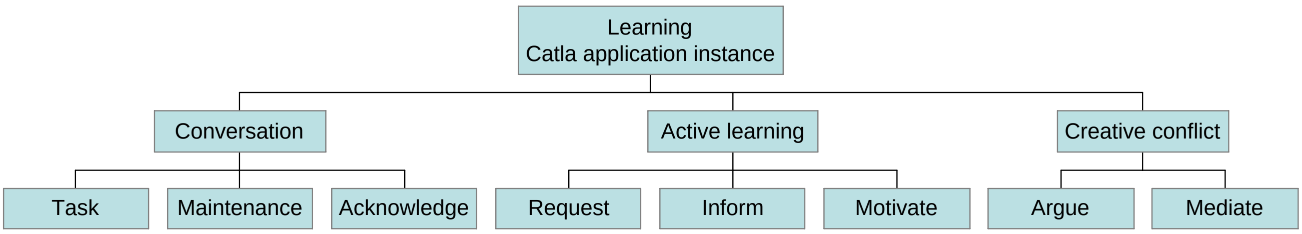

Figure 24: The collaborative learning process

Task	Maintenance	Acknowledge	Request	Inform	Motivate	Argue	Mediate
Co-ordinate group process	Request attention	Appreciation	Information	Rephrase	Encourage	Conciliate	Teacher mediation
Request focus change	Suggest action	Accept/ Confirm	Elaboration	Lead	Reinforce	Agree	
Summarize information	Request confirmation	Reject	Clarification	Suggest		Disagree	
End participation	Listening		Justification	Elaborate		Offer alternative	
	Apologize		Opinion	Explain/ Clarify		Infer	
			Illustration	Justify		Suppose	
				Assert		Propose exception	
						Doubt	

Table 7: The leaf nodes of the collaborative learning model

We realize that the leaf nodes of the model, which are presented in the table above, may be too generic for our purposes, and that one distinguishable objective in the near future will be to “instantiate” each with terminology that overlaps with the specific use context that our application targets. The current wording is not likely to make sense to our subjects.

However, as a “neutral” starting point, we have kept the terminology in the first version, in order to keep a stable terminology making tracking and re-design easier until a proper evaluation with real users can be carried out.

THE USER INTERFACE

The pertaining interaction design is something that we believe can be pursued in several planned steps within the project that we have outlined in this paper, in order to develop the specification into a boundary object that can aid the learning of appropriate strategies for diabetes patient which have to relay on simple and mobile, yet “smart” technology. One of the most important aspects of such a model would be to learn to live, and to live well, with being treated under a strict and permanent medical course of therapy.

The application comprises a simple mechanism for storing observations, which is a textual database. It is not a computationally optimized format, in any sense, but simply a straightforward way of embedding this information and the search clause of a Maude specification. It would typically look something like the following:

```
< 'steinar : Metric | timestamp: Fri Apr 25 15 : 17 : 22 CEST 2008
, exercise: No exercise, carbs: No carbs, insulin: Middle insulin >
< 'steinar : Metric | timestamp: Fri Apr 25 15 : 18 : 00 CEST 2008
, exercise: High exercise, carbs: No carbs, insulin: No insulin >
< 'steinar : Metric | timestamp: Fri Apr 25 15 : 19 : 08 CEST 2008
, exercise: No exercise, carbs: No carbs, insulin: High insulin >
```

The specification of the query is, however, not textual like above, but deducted from the application of the learning model described above, at the graphical user interface.

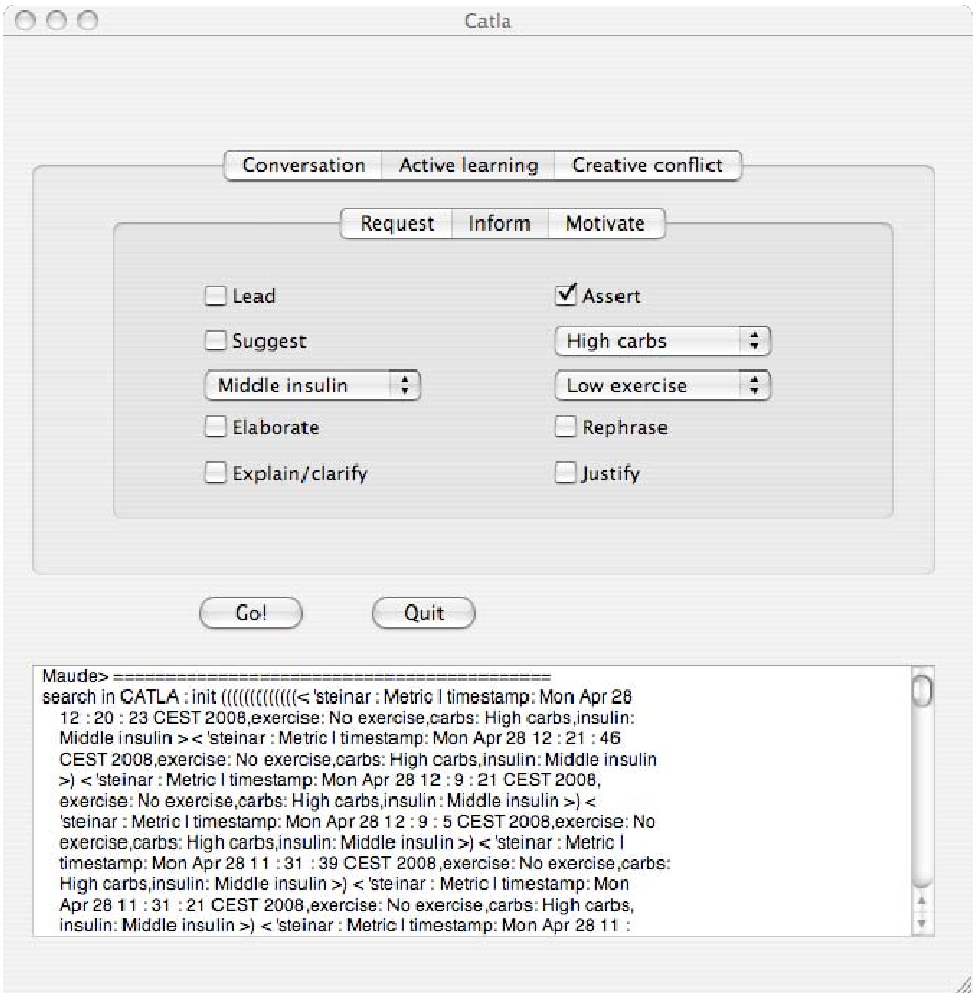

Figure 25: The user interface of CATLA

The user is intended to be looking up any of the *tabviews*, which comprise the categories corresponding to the higher levels of the learning model. The leaf nodes are accessed/addressed by ticking them off in the forms underneath. Any combination is possible, because the client translates them individually to messages in Maude, for the CATLA application to depart from when the state space is then explored. And this is a core aspect of this application, as it currently stands. It simulates not only the development, admittedly even that in a very rudimentary fashion, of the increase of blood sugar following variation of exercise levels and carbohydrate intake, or the pancreatic response to it. It also simulates the collaborative learning environment, and this is:

- The rationale and the expectation of the learning model to contribute to the motivation and change of behavior of the patient, by allowing it to be a vehicle for exploring the medically informed prediction of the body's physiological response.
- The contribution of interaction design (eventually) to the boundary object that is an harmonized aggregate of three distinct perspectives, each firmly rooted in four different professional domains:
    - Medical competencies concerning the pancreatic response to variations in exercise levels, carbohydrate intake, and insulin administration.
    - The pedagogical insight that is embedded in the collaborative learning model, and which be believe may be strengthened even further by the systematic assessment that we make possible through implementing it in CATLA.
    - Algebraic specification of the dynamic properties of the entire state space possible from a given initial condition. It can show the invariants governing the system, and allows a systematic and definitive exploration of its properties, relative to the current patient.
    - Interaction design, which is initially very rudimentary with regards to the approach to learning. On the other hand, it takes a long step in adapting a graphical user interface *as such* to the underlying infrastructure, so that the algebraic exploration is possible to begin with.

The presentation of the results from the queries is still rather simple, in the form of a textual response from the Maude interpreter. User friendliness, as such, is beyond the scope of the paper, however, which is to show that, albeit still raw in terms of usability, the boundary object constitutes a proper tool chain, which can be summarized in the diagram below:

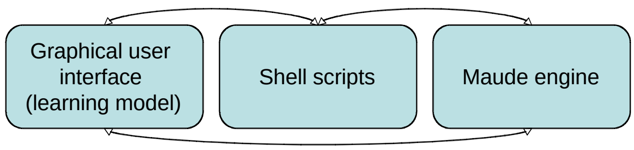

Figure 26: The tool chain architecture

Thus, the contribution of this paper is to demonstrate a prototype of a boundary object comprising physiological aspects, learning science and interaction design, onto a mathematical object by which the patient than explore his or her own insulin responses according to a provably correct model. It is not intended to be more physiologically "precise" than previous predication-oriented models, but it is our aspiration that it will to a larger extent contribute to changing patients' behaviors. For current state-of-the-art, this is where the expectations have failed to be met.

CONCLUSION

This is an early step towards designing an aid to people who have previously been underserved in terms of technological support for adherence to longitudinal medication. Many types of medical treatment are given as longitudinal cures comprising a combination of drugs. The amount, time and type of drugs that need to be administered may rely on many different factors, such as the stage of the illness, height and weight, the patients' level of activity or recent food intake, as well as interaction with other drugs. Numerous patients struggle to keep up with their cures, e.g., children, elders and patients in lesser-developed areas. Failure to adhere to the administration plan for longitudinal treatment of acute illnesses is often critical to the outcome of the cure (Atkins and Fallowfield 2006). We would like in particular to address the issues related to quality of life and outcome expectations from longitudinal cures for children.

Existing technology is generally too heavyweight and expensive, too intrusive and demands data that mobile users are not in a position to get. We have suggested to see the notion of this technology as a boundary object, in order to find ways around these practical obstacles, and at the same time setting ourselves up to provide a more pedagogical presentation of the algorithm which prescribes how much and when to take insulin, adjust the activity level or take in more nutrition.

We have seen many examples recently that mobile technology combined with the multifarious perspectives of friends and fellow users, medical consultants etc., have been established as normative and effective implementations in this respect[22]. Some of these systems are proven in practice (Prochaska, Velicer et al. 2005). Our project starts from the understanding that such approaches are instrumentally sound, but we wish in addition to develop a pedagogical element on top of that. Thus, the next step will be to assess with users whether the "boundary object" in our guise of a running Maude specification can be used as a way of learning more and better how to live well under longitudinal administration

[22] http://www.packitin.org/

of drugs. This will give us opportunities to explore the pedagogical outcome of the logical properties of the specification. We hypothesize that the assisted executions of search strategies on basis of the specification, to confirm in principle its potential as a boundary object. It may have to be re-implemented on top of a user-friendlier platform, in order for the specification to become a fully functional and “live” boundary object, which actually makes living with diabetes easier. This is the ultimate goal of this project, of course, but in terms of verifying the correctness of the underlying model, Maude is a promising tool.

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Theoretical Perspectives on Mobile Language Learning Diaries and Noticing for Learners, Teachers and Researchers

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ABSTRACT

This paper considers the issue of 'noticing' in second language acquisition, and argues for the potential of handheld devices to: (i) support language learners in noticing and recording noticed features 'on the spot', to help them develop their second language system; (ii) help language teachers better understand the specific difficulties of individuals or those from a particular language background; and (iii) facilitate data collection by applied linguistics researchers, which can be fed back into educational applications for language learning. We consider: theoretical perspectives drawn from the second language acquisition literature, relating these to the practice of writing language learning diaries; and the potential for learner modelling to facilitate recording and prompting noticing in mobile assisted language learning contexts. We then offer guidelines for developers of mobile language learning solutions to support the development of language awareness in learners.

Keywords

Second language acquisition, mobile assisted language learning, language learning diaries, noticing, open learner modelling.

INTRODUCTION

There is a large body of research on many aspects of second language learning, but often much of the relevant theory and empirical findings are overlooked by developers of language learning technology support. In this paper we consider ways to help the mobile language learner based on language learning research, focussing on explicit learner awareness of the language learning process.

In the course of acquiring a new language, learners develop an *interlanguage* (Selinker, 1972) – internalised language rules which may match neither those of the target language, nor the equivalent rules of the learner's native language. We consider in this paper ways to help learners 'notice' features of the target language (Schmidt, 1990), and facilitate 'noticing the gap' (Schmidt & Frota, 1986) between aspects of their interlanguage and the target language forms. Awareness-raising about language has been suggested to help focus learner attention on language (Rutherford & Sharwood Smith, 1985; Schmidt, 1990). In the context of current communicative/meaning-focused language teaching approaches, it has been argued that priming *noticing* in input (based on Schmidt, 1990) through Task-Based Instruction, negotiation of meaning and 'focus-on-form' based on developmental sequences (from Pienemann, 1987), can help language acquisition. While there is still no agreement on how language learning may best be facilitated through instruction, and despite the fact that the importance of noticing, or the extent of explicit noticing required for intake, have been debated (Truscott, 1998; Cross, 2002), some attention to language form is likely to be needed (Ellis, 2005). Furthermore, although whole-sale adoption of task-based 'focus-on-form' has been criticised on theoretical grounds and due to insufficient empirical evidence, the potential benefit of directing attention to language form as one of a repertoire of approaches, is still acknowledged (Swan, 2005).

Recent work on noticing confirms ongoing interest in approaches to prompt noticing to facilitate language acquisition in a range of contexts. For example, noticing has been explored with reference to oral output (Mennim, 2007); writing (Vickers & Ene, 2006); computer-based grammatical exercises (Shahrour & Bull, in press); and online text-based chat (Shekary & Tahririan, 2006). Wible et al. (2006) have developed a browser-based agent that assists learners in acquiring word collocations during unrestricted browsing of the Web - a 'noisy' environment in which the learner's attention needs to be drawn to examples of collocations that they might not otherwise have noticed.

In this paper we discuss how the second language acquisition literature on noticing can be harnessed to provide *theory-based support* to second language learners on their mobile devices. We first describe the traditional use of language learning diaries, then relate this to mobile language learning opportunities, and consider the benefits of modelling learner knowledge in this context. Finally we offer guidelines for designers and developers of mobile language learning software where the aim is to prompt learner reflection, metacognition and noticing.

EXPLICIT RECORDING OF NOTICING

It has been suggested that identification of what learners notice through collection of introspective data is likely to give a clearer picture of what learners attend to, than other methods might (Al-Hejin, 2004). This section is in three parts. We first consider one of the traditional methods of encouraging learners to explicitly note aspects of language, or the language learning process: language learning diaries. Such diaries allow detailed (though often unstructured) insights into learner language. We then suggest how recording of noticed elements at the time of noticing might be facilitated using a mobile device, and how modelling noticing more systematically may further enhance the learning process in mobile contexts.

Language Learning Diaries

Language learning diaries are used by various parties involved in the second language education context. Diary studies have been defined as "first-person case studies" (Bailey, 1991), and can provide insight into learners' explicit thoughts about their knowledge or the learning process: learners record aspects of their learning in their diaries, which may include their thoughts, feelings and attitudes about their learning, or features of the target language that they notice. This is best done within an environment where learners have a certain degree of autonomy, i.e. the freedom to make some decisions about their learning such as taking responsibility for objectives, content, progress and method of learning (Macaro, 1997; Palfreyman & Smith, 2003). The diary can be part of the formal learning process, but it can also be an informal or complementary activity.

Language learning diaries have been written by:

i. *students*, to help focus their attention onto their language learning strategies (Oxford et al., 1996), increase their language awareness (Allison, 1998) and promote reflection on the target language (Simard, 2004);
ii. *trainee teachers*, to encourage a reflective approach amongst trainees (Flowerdew, 1998);
iii. *researchers*, providing examples of the potential of the diary approach (e.g. Schmidt & Frota, 1986).

In addition, teachers have used students' diaries to help them to better understand the needs of their students (Teng Sze Mei, 2003); and the link has also been made between diaries and blogging (Suzuki, 2004).

In this paper we are interested in particular in the issue of facilitating and recording noticing (Schmidt, 1990). As an illustration of the potential for language learning diaries for recording the occurrence of noticing, we present an example from a diarist quoted in Stakhnevich (2005):

> "Today was the day of *el imperativo*. No matter what I did or where I was, I kept noticing various types of imperative verbal forms. For example, on the bus I noticed a flyer encouraging people not to throw their trash on the street: '*No tires basura!*' At the bus station, I saw another poster advertising a new Mexican movie '*Dame tu cuerpo*'. On the return bus, I kept hearing how the parents were giving commands to their children: '*Dámelo!*'". (Stakhnevich, 2005:223)

The above excerpt demonstrates the learner's increased awareness of the imperative form in the language input to which they were recently exposed. Presumably they had also been exposed to this previously, but only at the point of recording this information had they become explicitly aware of the imperative form to this extent. Such information can be used as a reminder for the learner and, of course, the act of formulating the entry for their diary may also help to consolidate their new knowledge. This information is also of interest to applied linguistics researchers who are investigating issues relating to noticing, and may also reveal useful information about their students, to language teachers.

We are interested in considering how this kind of explicit approach to noting language features may be facilitated in a convenient manner by new technologies. In the following section we expand on the above, suggesting how mobile learning applications could be usefully applied to facilitate the recording of noticing.

Recording Noticing using Mobile Devices

The growing popularity of personal technologies offers new opportunities for technology to support and transform language learning; technological advances have led to increased interest in educational use of mobile devices (see Kukulska-Hulme & Traxler, 2005). A key part of language learning for many learners is a short or prolonged visit to a country where the language is spoken, for example: for business purposes, as a language student, or as a tourist. Personal mobile devices lend themselves to activities that take advantage of ready access to information and data collection in different contexts. For second language learners this includes being able to capture examples of language, in electronic form (e.g. using text or voice input), along with observations about how the language is used. This fits especially well with the idea of noticing aspects of language (Schmidt, 1990) since, as illustrated in the excerpt from Stakhnevich (2005) above, noticing may occur in a range of locations at a variety of times, and from different forms of language input. The availability of a mobile device can facilitate the recording of noticing conveniently in different locations - i.e. learners can be supported as they notice during their daily routine, using a device that they would normally be carrying with them. Mobile scenarios particularly conducive to noticing include situations where learners can be unobtrusive observers of language in use, e.g. when travelling and listening to the radio, or when attending an event such as a seminar or a conference.

Recording noticing in this manner is similar in essence to the use of a language learning diary. As indicated above, such diaries allow learners to explicitly record noticed language elements or other aspects of their learning. Recording noticed features with a mobile device 'on the spot' provides a different method of obtaining data on what learners notice to complement existing experimental approaches to researching second language learner processes (see Wigglesworth, 2005), which may be of interest to Applied Linguists.

Allowing learners to tag noticed elements in a systematic way will offer additional benefits. Data collected through a convenient computer-based method can be made more readily searchable and easier to manipulate for both learners and researchers: to facilitate noticing for the language learner and to facilitate data collection for the researcher. Such a method of data collection could contribute further evidence to the debate about the importance of noticing in language learning. Data from a specific group can also be used by teachers to inform their teaching for that target group, which may be especially useful for less experienced teachers; and data from an individual could, of course, help language teachers address specific needs of a student. We therefore recommend the use of mobile devices to record noticing in a fitting and straightforward manner, to facilitate the development of explicit awareness of target language features to complement their other language learning activities.

Modelling Noticing

Given our assertion that mobile devices could be effectively employed to record noticing by the language learner, and the potential interest of this data to teachers and researchers, we suggest also that capturing this information in a learner model could be of benefit to all parties.

In order to adapt appropriately to the needs of the individual learner, adaptive learning environments maintain a model of the learner's understanding (e.g. knowledge, skills, difficulties, misconceptions), inferred from their actions in the environment (such as responses to questions, tasks of various forms, browsing, or requests for hints or help). This learner model is a model of *current understanding* (i.e. it is not a performance score or list of correct/incorrect answers), and is typically used together with a model of the domain (the target features of the second language), to allow the environment to infer appropriate individually tailored teaching, coaching or guidance strategies to meet the student's specific current learning requirements. For example, the learner and domain models can be compared for the selection or generation of appropriate materials, feedback, exercises or tasks for an individual. Previous work has investigated the potential for modelling aspects of interlanguage and learner language, to assist learners in PC-based intelligent computer-assisted language learning environments (e.g. Michaud & McCoy, 2006; Schuster & Burkett-Picker, 1995). Such learner modelling could also be applied to mobile language learning diaries. Learners may not only record language elements that they notice, as described above, but these noticed items can also contribute to the learner modelling process. Using a mobile device, a student could record noticed elements at the time of noticing, to contribute to their learner model information - thus linking the traditional language learning diary approach to the learner model. Learner models to represent explicit knowledge of language features can be built, based in part on a learner's direct contributions, and in part on inferences made according to those contributions (e.g. the system can infer that if a learner has noticed Y, they probably already know X). Based on findings in the second language acquisition literature, a language learning environment could also predict how a learner is likely to progress (see Bull et al. (1995) for a learner modelling example). This information could, for example, be used as a basis to prompt further noticing (e.g. by suggesting to learners what they should look out for next, given the current state of their knowledge).

Although the learner model is traditionally used to inform system adaptation to the individual, there is now growing interest in opening the learner model to the learner it represents, in an understandable form (i.e. an 'open learner model'). An important reason for allowing the learner to access their learner model content is to provide them with information about their understanding to prompt reflection on their knowledge, and on the learning process (Bull & Kay, 2007; Dimitrova, 2003; Mitrovic & Martin, 2007). Often this is discussed within a framework of metacognition, but in language learning it relates closely to the second language acquisition literature on noticing (see above). Thus externalising the learner model to the language learner can be designed to help prompt noticing. Comparing their learner model to an expert/domain model of the relevant target language features (Shahrour & Bull, in press) can also lead students to notice the mismatch between certain features of their interlanguage and the corresponding target language norms as in Schmidt and Frota's (1986) 'noticing the gap', as a starting point to modification of their interlanguage.

This approach has been shown to have potential in language learning: it has been demonstrated with the 'Notice' system that an open learner model can help prompt noticing using salience techniques to highlight learner model information, and that many of the learning gains made during use of the open learner model were retained one week after the experimental session (Shahrour & Bull, in press). Part of the Notice open learner model is shown in Figure 1, for one of the verb types modelled in the simple past tense. Highlighting is used to raise learner awareness of the target forms, with the colour of the highlight indicating the learner's level of understanding of application of that rule. (Here 'limited knowledge' is indicated by brown (boxed) text; the node preceding the type of verb is also brown; the verbs in the examples are highlighted to match the learner's level of knowledge. The final sentence shows the form(s) that the learner is using (currently three, thus these three are indicated in the sentence for the learner to consider). This aims to prompt the learner to 'notice the gap' between their output and the target forms (Schmidt & Frota, 1986).

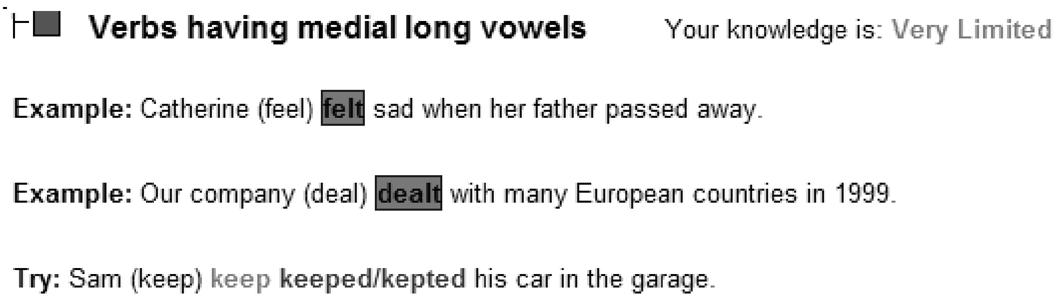

Figure 1. Excerpts from the open learner model of 'Notice' (Shahrour & Bull, in press).

Figure 1 is just one example of how an open learner model might be shown. Figure 2, from Flexi-OLM (Mabbott & Bull, 2006), illustrates three other open learner model structures for comparison (concept map, prerequisites structure and hierarchical relationships between concepts), which also use colour to indicate knowledge level. Further information about their knowledge can be gained by the user, by clicking on the coloured nodes.

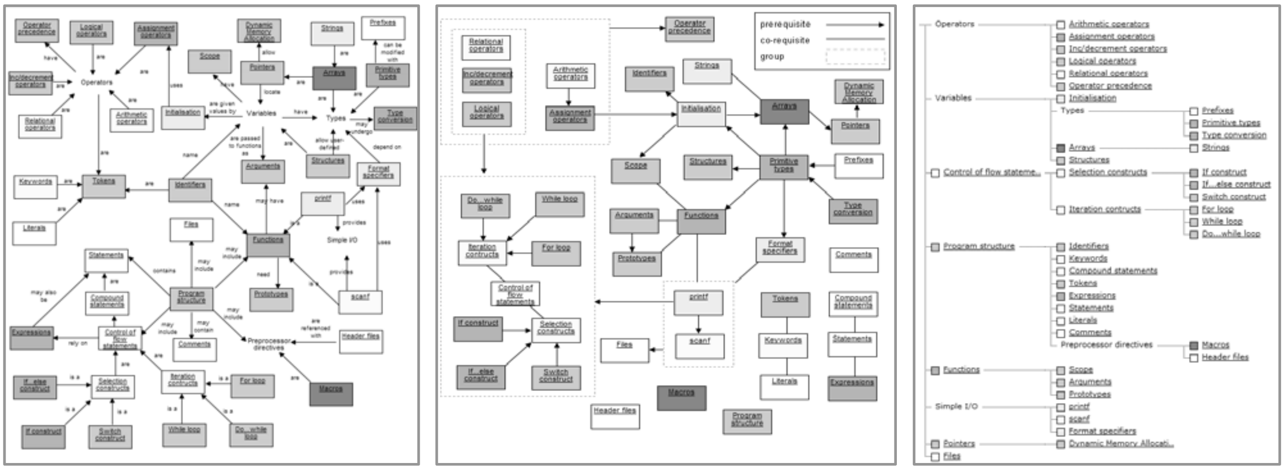

Figure 2. Three of the structured open learner model views of 'Flexi-OLM' (Mabbott & Bull, 2006).

The structures in Figure 2 are used in an open learner model for C programming, but suitable structured open learner models could also be defined for language learning. For example, they could be structured according to functions of language or grammatical forms; following Pienemann's (1987) notion of natural developmental sequences; or according to the likelihood of language transfer (Odlin, 1989) with reference to the learner's native language, etc. Thus an open learner model for language learning need not necessarily be presented as in Figure 1.

Notice and Flexi-OLM are 'independent open learner models' (Bull et al., in press) - learner models that are inferred in the usual manner, but that are not part of a larger tutoring system. A key purpose of independent open learner models, in addition to prompting knowledge awareness as described above, is to facilitate formative assessment and promote learner independence: rather than an environment inferring a learner model in order to be able to adapt the interaction to guide the individual user, the learner model is the core of the environment. Learner access to their learner model gives the user explicit insight into representations of their understanding, which they would not normally see (as in open learner models in general), but the primary aim is that they should use this information to identify their needs for themselves, and then undertake the appropriate work to overcome any difficulties. This focus fits well with Macaro (1997) and Palfreyman and Smith's (2003) view of the value of language learner autonomy and responsibility, mentioned above; and heightens the importance of learner responsibility and control over their learning as can be provided by open learner modelling (Kay, 1997). While system suggestions for what to look out for according to the learner model information (see above) would be very useful in this type of language learning context, the particular focus on knowledge-awareness typical of independent open learner models, is especially relevant to noticing in language learning. Increasing the role of the learner model for promoting learner independence alongside helpful system prompts for noticing, would be particularly useful in a mobile language learning diary context.

COMPARISON TO EXISTING WORK ON LANGUAGE LEARNING SUPPORTED BY HANDHELD DEVICES

With a few exceptions (e.g. Cui & Bull, 2005; Ogata & Yano, 2003 and 2004), relatively little attention has focused on language learning environments that have the ability to adapt to the user's knowledge with reference to the mobile context. In this section we describe the general direction of current research in mobile language learning, and then highlight how the modelling of learner language might be beneficial in mobile situations where one of the goals is to prompt noticing or raise learner awareness.

As described by Kukulska-Hulme and Shield (2007), mobile-assisted language learning (MALL) studies are divided between those that are largely content-based, i.e. focusing on delivering and evaluating traditional language learning content and exercises to learners in formal education, and those that concentrate on design issues related to developing new kinds of learning materials and activities specifically tailored for mobile devices and mobile contexts of learning. In the latter case, it is noticeable that learners are expected to take control of what they learn rather than having pre-defined learning delivered to them; however this approach is not yet widespread:

> Mobility and portability too often seem not to be fully exploited in the design of MALL activities… Many of the studies also ignored the 'anytime, anywhere' affordances supposedly offered by mobile devices; for example, SMS messages were sent to learners at set times, on set days… rather than learners being able to obtain this information as and when they wanted it. (Kukulska-Hulme & Shield, 2007: 11)

To take full advantage of mobility, some researchers have begun to design more personalised experiences relevant to language learners' changing circumstances and needs. Ogata & Yano (2003 and 2004) describe a computer-supported ubiquitous language learning environment that interacts with sensors in the environment to provide learners of Japanese with the appropriate polite expressions for their current context. The system supports collaboration between learners via a bulletin board and instant messenger-like chat tool, so that learners are able to see who entered a particular expression and can use the communication tools to ask questions about it. To encourage learning from authentic and immersive contexts, Fallahkair et al. (2007) have designed a system that supports language learning activity on mobile devices tied in with watching everyday television programmes selected by the learner in their home. For those who are studying in a foreign country, Shao, Crook and Koleva (2007) propose a mobile group blog to support enculturation through learner-driven sharing of observations about local language use and local customs. What these strands of research have in common is a concern with providing support for understanding and producing language in specific contexts that correspond to learners' current needs.

In general, the approach of open learner modelling allows the creation of an individually personalised environment for use in a mobile context, suitable therefore for students at different stages of language acquisition, with different language backgrounds, and different individual difficulties. However, a primary aim of this approach is to gain some of the benefits found from the traditional paper-based language learning diary: facilitating the recording of language as it is used. This information may be helpful to language learners, teachers and researchers in a similar manner to the conventional diary; but the electronic form will enable additional search capabilities and easy access to information at times when the learner has a few minutes to spare to benefit from short learning opportunities between other scheduled activities (see e.g. Cui & Bull, 2005). The learner modelling may allow both adaptation to the individual learner in their particular mobile learning context and activities, and promote reflection and noticing from the student's recording of noticed features and the facility to view their learner model.

The modelling of learner language could be particularly beneficial in situations such as:

1. students spending a period of study abroad, who are uniquely placed to notice local language use, e.g. within social circles and subcultures that are not readily accessible to outsiders
2. professional updating among migrant workers who need to notice current phraseology, specialist terms and colloquialisms that are part of daily professional practice in their field
3. continuous teacher development, where evidence from learner noticing can raise teachers' awareness and enrich their understanding of real language issues encountered in communication outside the classroom

GUIDELINES DRAWN FROM THEORY

Based on the literature on noticing in language learning, much of which is based on Schmidt's (1990) noticing hypothesis, and the relationship of this body of research to language learning diaries, we recommend supporting or prompting noticing and the explicit recording of noticing by learners. This can be achieved conveniently using students' usual mobile devices. We argue that this approach could be of use to several groups: the students themselves, to facilitate noticing; language teachers, to help them better understand the specific needs of individuals or a group; and applied linguistics researchers. Such an approach could be designed specifically to facilitate noticing in a particular context, such as the examples of studying abroad, professional updating and teacher development above, or could offer additional benefits embedded in other mobile-assisted language learning approaches. Based on an examination of the literature, our recommendations to application designers and developers of environments to support the recording and facilitation of noticing are:

- Listing typical difficulties of a targeted language group will help in the design of an environment to address the specific difficulties of learners - i.e. it can help in determining suitable language elements to suggest learners look out for in their daily activities and communications. These could be elements such as forms of address, question tags, modal verbs, prepositions, and so on; some will be location-specific, for example features of a dialect.
- Consideration of the processability of features at different stages of learning will assist in the identification of elements to look out for more generally. This can be done by targeting the language features that learners should be focusing on in the next stage of their language development.
- Familiarisation with the concept of 'noticing' in language learning will help in fostering explicit language awareness in learners, and highlighting the benefits of encouraging such awareness. This can be done, for example, by showing a video of learners describing what they have noticed and how it has helped them; this video can be made available on a learner's mobile device.
- The language learning diary literature will help in the familiarisation of how learners may naturally record explicitly noticed language features. This should assist in the design of an environment allowing learners to contribute information about their noticing, to suit the specific aims of a course; or for the inclusion of such an approach within a mobile-assisted language learning application.
- Inclusion of even a simple learner modelling approach. Opening the learner model to the learner, for them to view and contribute noticed elements to their learner model, will help individualise the interaction to suit the specific needs of the learner, and encourage formative assessment and reflection. Periods of commuting and travel would be conducive to such reflection.
- Consultation of the second language acquisition literature on salience techniques can help identify methods to direct learners' attention to elements of particular relevance in their learner model. Sharwood Smith (1993) notes positive and negative salience techniques, namely increasing the salience of correct forms or words, or drawing attention to the learner's errors. This can be implemented by highlighting, boldening, underlining, capitalising or italicising text.
- Noticing may be more motivating and more effective if combined with opportunities to communicate with others about what has been noticed. Sharing open learner models with peers is one way in which spontaneous face to face discussion about learner knowledge may be facilitated. Instant messaging and social networking on mobile devices can assist this dialogue.
- Learners should be able to take control of what they learn, in the sense of being able to direct at least some of their learning towards goals that meet their individual needs, rather than relying entirely on pre-defined learning being delivered to them. This is in line with the independent open learner model approach, where there is a focus on learner responsibility, and suitable for the mobile assisted language learning context where goals can change focus in response to the learner's environment.

CONCLUSIONS

This paper has described some of the theoretical language learning literature relating to noticing and its effect on learner language; how this relates to the use of language learning diaries; and how this diary approach could be facilitated using mobile devices which learners will normally be carrying with them. Based on these theoretical considerations, we offer guidelines for mobile learning researchers and system developers interested in explicit recording and facilitation of noticing - information of relevance to learners, teachers and researchers. Our guidelines focus on identifying language elements that learners can be encouraged to notice, promoting and illustrating the actual processes of noticing, enabling learners to reflect individually and collectively, and being open to the inclusion of learners' own goals. Researchers and teachers wishing to test the effectiveness of the guidelines would need to evaluate each of these aspects and consider the relationships between them.

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Survey on Context-Aware Pervasive Learning Environments

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ABSTRACT
Context-aware pervasive learning environments consist of interconnected, embedded computing devices such as portable computers, wireless sensors, auxiliary input/output devices and servers. Until this study there has been no survey that has evaluated and presented information regarding these environments. In this paper, we conducted a survey to identify the commonly used technologies, methods and models behind these systems, and evaluated the role of mobile devices in the reviewed papers. As a result, we made five observations: (i) RFID was the most common sensor technology; (ii) several learning models were suggested, but none was validated properly; (iii) client-server architectures are prevalent in the systems and mobile devices were used most commonly to represent information; (iv) most of the systems supported multiple simultaneous users, but few facilitated virtual communication; and (v) possible roles for physical environments in pervasive learning systems are: contexts for learning, content for learning, and system resources. Evidence indicates that suitable learning models have yet to be validated, and that more roles of mobile devices could be emphasised.

Author Keywords
Pervasive learning, context-aware, mobile learning, learning models

BACKGROUND
Mobile learning, or m-learning, has become popular and is currently being intensively researched. In this paper we consider m-learning to refer specifically to learning facilitated by mobile devices such as PDAs and mobile phones. The primary aim of m-learning is to provide the users with a learning environment which is not restricted to a specific location or time. Compared to a traditional classroom setting, m-learning increases the mobility of a learner, allowing him/her to learn while sitting in a bus, for example. Furthermore, networked mobile devices allow learners to perform co-operative learning tasks in a group.

Pervasive learning is the latest trend in harnessing the technology to support learning. In this form of learning, the mediator is a pervasive computing (also known as situated computing, ubiquitous computing, embedded computing, ambient intelligence, or everyware) environment which consists of interconnected, embedded computing devices such as portable computers, wireless sensors, auxiliary input/output devices and servers. One could therefore consider pervasive learning as an extension to m-learning where the roles of the intelligent environment and of the context are emphasised. The physical environment is central as it provides salient resources for learning. According to Syvänen *et al.* (2005), a pervasive learning environment (PLE) is a setting in which students can become totally immersed in the learning process. They further note that pervasive computing is an immersive experience which mediates between the learner's mental (e.g. needs, preferences, prior knowledge), physical (e.g. objects, other learners) and virtual (e.g. content accessible with mobile devices, artefacts) context. The intersection of these contexts is referred to as *pervasive learning environment* (Syvänen *et al.*, 2005). Syukur and Loke (2007) regard a PLE as a collection of mobile users, mobile services, mobile devices, contexts and policies, while Ogata *et al.* (2006) state that in pervasive learning, computers can obtain information about the context of learning from the learning environment in which embedded small devices, such as sensors, pads and badges, communicate together. Common to these definitions is the interplay of intelligent technology and context in which the learner is situated (i.e. context-awareness). Compared to traditional learning environments, PLEs provide more interaction with the environment. Furthermore, in properly designed PLEs, learning materials are delivered in a correct format at the right place and at the right time. PLEs can be deployed not only at traditional learning contexts but also for example in corporate training settings, museums, exhibitions, and tourist attractions. In this paper, PLEs are based on environments with embedded intelligence in the form of sensors, tags and interaction devices.

There has been research conducted on building and evaluating PLEs, however no survey has yet evaluated these environments. Such information is necessary not only for avoiding reinventing the wheel, but also for understanding the current state-of-the-art in this area. By recognising the commonly used technologies, methods and models, we can design and build PLEs more effectively. Our intention is to provide an overview of what kind of PLEs have been developed, how they were built, what are the sensor technologies used in these systems to make them context-aware, what learning models are suggested for these environments, and what are the roles of mobile devices. By reviewing existing work, we seek to build a solid ground for further research on how different learning models can be efficiently utilised in PLEs and what are the critical features of such an environment. The role of mobile devices is an important factor from the perspective of wider work which aims to design and implement a flexible pervasive mobile learning system. This work also includes establishing and recognising the best learning models for such system.

The paper is organised as follows. We first define the methodology used in the survey and continue by describing the observations resulted from the analysis of the literature. Finally, we conclude by discussing implications of the results and concluding the findings.

METHOD

This section presents the research questions and designs of data collection, evaluation and analysis.

Research questions

In this survey we focused on articles presenting research outcomes that included a design, implementation, evaluation or test of a context-aware pervasive learning environment. We established a set of questions to be answered with the information extracted from the literature. These questions and their purpose are presented in Table 1.

Question	***Purpose***
1. What are the currently existing context-aware pervasive learning environments and how are they built?	We seek to discover the state-of-the-art in the field of context-aware pervasive learning environments. The survey is done from a technical perspective, emphasising particularly technologies for smart environment (e.g. sensors).
2. What learning models, if any, have been established to support pervasive learning experiences in these environments?	We consider this question particularly relevant because if there are no learning models established or validated in the previous work, we will have a rationale to conduct further research on the learning models in this field. If previous work supports particular learning models for pervasive learning, those can be used together with newly established models in the future work.
3. What is the role of mobile devices in existing pervasive learning environments?	This question is intended to find out how mobile devices have been harnessed in existing pervasive learning environments. The results of this question will be used to invent and combine ways to utilise mobile devices in pervasive learning.

Table 1. Research questions and their purpose

Data collection

In order to collect the data in a reliable and reproducible manner, we devised a set of rules for paper inclusion. The established inclusion rules were as follows.

- The work describes a design, implementation, analysis or test of a pervasive learning environment or system.
- The presented environment/system uses sensors or other technologies for smart environments to enable context-awareness; having people walking around with mobile devices connected to a wireless network was not enough as it is merely m-learning.
- The work was presented in one of the following forums: IEEE International Conference on Pervasive Services, IEEE International Conference on Pervasive Computing and Communications, European Conference on Ambient Intelligence, International Conference on Mobile and Ubiquitous Systems, IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE & WMUTE), Pervasive E-Learning Workshop, Pervasive Computing Education Workshop, Pervasive Learning Workshop.
- Data from one work does not overlap data from another work. In the case that two or more papers present the same system, the most recent or more comprehensive one was selected.
- If the study does not present the design, implementation, evaluation or test of a pervasive learning environment, it must discuss the suitability of learning models and styles to an existing pervasive learning environment.

All works that failed to meet these rules were excluded. After establishing the inclusion rules, we performed the data collection in two phases. In the first phase titles and abstracts of articles presented in the given forums were read. If the title of an article did not seem relevant (e.g. the field was completely different), the abstract was not read. If the article showed relevance based on the title and the abstract, it was selected to the second phase. In total 35 papers were evaluated suitable as a result of the first phase.

In the second phase, the abstract and the introductions were read, and based on that information part of the papers were excluded as they did not meet the inclusion rules. After the second phase the number of relevant papers was decreased to 18. We recognise that this is not a comprehensive survey from the paper point of view. However, the purpose of this paper is not to be a comprehensive literature review, but rather a directed probe into pervasive computing, learning and technologies.

Data evaluation

After the main body of the papers was collected, we proceeded to read through the remaining papers in order perform a deeper analysis of the data and extract relevant information. For this purpose, we established a set of questions to be answered with that information. The questions are based on the research questions and they are as follows.

- Q-A0: What are the description and purpose of the system/environment?
- Q-A1: Is it based on a client/server approach? If not, what is it based on?
- Q-A2: What is the hardware/software platform of the system?
- Q-A3: What is the programming language used in development?
- Q-A4: What kind of sensors are used and how?
- Q-A5: What is the role of the physical environment in the system?
- Q-A6: Is it a multi-user system?
- Q-B0: Are learning models discussed?
- Q-B0a: If yes, what are the suggested learning models?
- Q-B0b: How the suggested models have been validated?
- Q-B1: What learning activities does the system support?
- Q-C0: What is the role of mobile devices in the system?

In these questions A, B and C refer to the research questions 1, 2, and 3, respectively. The question Q-B0 has two sequential questions, namely Q-B0a and Q-B0b, which are only answered if the Q-B0 has a positive answer. We could not extract answers to all these questions from every paper, but majority of the papers had sufficient information available. During the evaluation process we excluded 4 papers as deeper analysis showed that they did not meet the inclusion rules, reducing the number of included papers to 14. However, as one of the papers presents 2 different systems, the total number of relevant works was 15. The observations based on the information extracted from these papers are presented in the following section. Papers that were part of the survey but are not referred to elsewhere in this article are: Barbosa *et al*. (2006), Grew *et al.* (2006), Ogata and Yano (2004b) and Weal *et al.* (2007).

OBSERVATIONS

After the data evaluation, we performed a deeper analysis on the extracted information. As the result, a set of observations was established. These are presented in table 2 and in the following sections we present each observation in detail. The questions presented in 2.3 are linked to the observations with the question codes in parentheses.

Observation 1	RFID (Radio Frequency IDentification) is the most prevalent sensor technology used in pervasive learning environments. (Q-A4)
Observation 2	There are several learning models that are suitable for different learning activities in pervasive learning environments, but none of them was validated properly (Q-B0, Q-B0a, Q-B0b, Q-B1)
Observation 3	The vast majority of the systems are based on a client-server architecture and most of them utilize mobile devices in various ways; content representation tool is the most common role for mobile devices. (QA-1, QA-2, QA-3, Q-C0)
Observation 4	The majority of the pervasive learning environments support multiple simultaneous users, but only a small number support virtual communication among the users. (QA-6)
Observation 5	Currently established roles for the physical environment in pervasive learning systems are: context for learning, content for learning, and system resource. (QA-5)

Table 2. Observations on context-aware pervasive learning environments

Observation 1

From the reviewed works, the most commonly used sensor technology was RFID (Radio Frequency IDentification) as 9 out of 15 works mentioned it explicitly. The second most popular sensor technology was GPS, scoring 4 hits in total. Other explicitly mentioned sensors were light sensors, moisture sensors, wired trigger sensors, water flow sensors, piezoelectric “object usage” sensors, force sensors, temperature sensors, humidity sensors, infra-red distance sensors, motion sensors, touch sensors, cameras, 3D accelerometers and microphones. Two works did not explain what kind of sensors are used as they merely presented the possibility of using sensor technologies in the respective systems. From the 13 works that mentioned some sensors being used, 7 utilized more than 1 sensor type.

RFID has been successfully used for sensing nearby persons (Derntl and Hummel, 2005), physical resources (Derntl and Hummel, 2005; Beaudin et al., 2007), locations of the user or objects (Ogata *et al.,* 2006; Derntl and Hummel, 2005; Beaudin *et al*., 2007), and the user's actions (Beaudin *et al.,* 2007). In addition to a presenting a pervasive learning environment, Sakamura and Koshizuka (2005) mentioned two ambitious ongoing projects in Japan, namely *food traceability* and *location-aware computing*. The goal of the former project is to attach RFID tags onto all food products, thus increasing the visibility of the food production chains. The latter project aims to tag all places in Japan's national infrastructure, thus supporting efficient transportation, sightseeing and also pervasive learning. Most of the pervasive learning applications that utilised RFID technology used RFID reader embedded or attached (via Bluetooth or by using extension slots) to mobile devices to read the tag information. This might be an indication that RFID is likely to become the next big thing in mobile wireless near-field communication just like Bluetooth did a few years back.

Observation 2

Out of 15 works only 7 discussed learning models and most of them did not explicitly suggest their suitability. However, we were able to extract the learning model types supported in each system by carefully analysing the descriptions of system functionalities. As a result, we devised a list of learning models that could be used in pervasive learning environments. Many systems supported more than one of these models simultaneously, e.g. a system could be both group-based and problem-based. Table 3 presents the extracted learning models and examples how they were used.

Learning model	***Example***
Group-based learning	Kusunoki *et al.* (2002) propose a system which utilizes an RFID-enhanced interactive sensor board for museums. The idea is that when an object is placed on the sensor board, a projected image on the board shows more information about that object. The board is able to recognise multiple objects simultaneously, thus a group of learners can communicate and learn at the same time.
Individual learning	Mitchell and Race (2005) present a system in which children gather information pertaining to a range of reptiles, small mammals, insects, fish and birds both within indoor and outdoor environments. Camera and 2D bar codes are used to collect the information. The children perform the activities independently and communication between the users is not supported by the system. Naturally, ad-hoc face-to-face communication may occur, but learning is mostly individual.
Microlearning	Beaudin *et al.* (2007) constructed a pervasive environment for learning a foreign language according to the model of microlearning, in which users are continually given small chunks of knowledge. The goal of the system is to teach vocabulary through the usage of responsive everyday objects in a household. When a learner interacts with an object, the vocabulary related to it is played back as sound.
Authentic learning	Ogata and Yano (2004a) propose two different systems; JAPELAS for learning polite Japanese expressions through situations, and TANGO for learning vocabulary about the surrounding objects. According to the authors, both of these system are particularly well suited for authentic learning as language skills are best acquired in a real-world environment. The same authors have created the JAMIOLAS pervasive learning environment (Ogata *et al.,* 2006), which allows users to learn Japanese mimicry and onomatopoeic expressions through authentic situations. For example, when a user goes out and it rains, the system tells the user onomatopoeia for raining. The authors explicitly refer to this learning activity as authentic learning.
Learning by playing	The pervasive learning environment constructed by Lampe and Hinske (2007) consists of a set of RFID- and sensor-enhanced toys and a mobile device. In the “Knight's Castle”, the toy characters respond to children's actions by, for example, telling a historical story or singing a song. This system is a good example on how a pervasive learning environment can be used in a playful manner

	to educate children.
On-demand learning	Ogata *et al.* (2007) present a pervasive learning system (LORAMS) in which mobile videos and RFID-tagged objects are used to record and share learning experiences. There are two types of user role in the system: movie provider and movie watcher. In the latter role, users retrieve movies from the system according to the context, so the learning material is acquired in an on-demand basis, thus we can refer the learning activity of the second user role as on-demand learning.
Hands-on / Minds-on learning	The pervasive learning environment (LORAMS) presented by Ogata *et al.* (2007) supports learning by hands-on experience (see "On-demand learning"). The motivation for the system was to provide a tool to record a learner's experience and share it later with other learners. Hands-on activities are particularly useful here, as after recording, they can be easily imitated by other learners.
Problem-based learning	Derntl and Hummel (2005) describe a pervasive learning system for a university laboratory in which learners are provided with a set of learning activities to perform. The objects in the lab are equipped with RFID tags so the system is aware what the users are doing at any given moment, and can therefore monitor the progress of the learning activities. Learning activities are represented as complex problems to be solved, hence problem-based learning.

Table 3. Learning models in pervasive learning environments

Ogata and Yano (2004a) suggest the most suitable learning models for pervasive learning are on-demand learning, hands-on or minds-on learning, and authentic learning. They further divide authentic learning into action, situated, incidental and experimental learning. The authors particularly emphasize the effectiveness of authentic, contextual learning for learning a foreign language. It is clear, however, that authentic learning is suitable for any kind of learning need where environment and context are major factors.

Despite several learning models being presented in the papers, few were tested or validated. Microlearning was tested by Beaudin *et al.* (2007) by running a non-stop scenario for several weeks. Participants in the test were optimistic about the possible use of technology and they showed increased level of knowledge of their foreign language vocabulary. However, as the scenario was executed only for two test subjects, this result does not yet validate the usage of microlearning in sensor-enhanced pervasive learning environment, but neither does it disprove the positive effect of the technology on learning. The system presented by Mitchell and Race (2005) (independent learning) was validated by two test settings; an initial user study with a small group of children, and an investigation of overall performance of the system. The results of the former test suggested that the children enjoyed using the system and the overall feedback was positive. The school staff members were also supportive towards the usage of the system. The performance test concentrated on how the process of capturing an image and awaiting a response affected the usability of the system. The time of the process varied from 6 to 26 seconds, depending on the status of the GPRS connection. The performance test did not validate the learning model directly, but it did indicate suggest that the system is usable. In the third validated system (Ogata *et al*., 2007), the authors set up experiments in which groups of students assembled a part of a computer; one group used Google to retrieve information and the other group used the LORAMS system to watch videos previously recorded by other students who had had the same learning experience earlier. The results suggest that LORAMS helped the students of the latter group perform better than the first group.

Observation 3

All except one of the reviewed systems use a client-server architecture, and the exception implements a touch-based and RFID-enabled sensor board in a museum (Kusunoki et al., 2002). In this stand-alone system, the sensor board is directly connected to a computer which also manages the video projector used to project an image onto a board. The projected video is adapted to user actions and objects places on the board. Of the client-server based systems, two systems also allowed ad-hoc peer-to-peer communication without server intervention.

Details of hardware and software were not given in many of the reviewed papers and none presented a thorough technical description. Therefore, the following information may not correspond to all the state-of-the-art technologies used in pervasive learning environments. The operating systems of the mobile devices were Windows Mobile, Windows XP and Symbian OS. On the server side, XML was used for encapsulating data and messages. Furthermore, Sakamura and Koshizuka (2005) used TRON (The Realtime Operating system Nucleus) operating system on the server. In other systems the operating system was not explicitly mentioned. Communication between the server and the client was established either by GPRS or WLAN, and two papers mentioned the usage of the HTTP protocol. The programming environment on the server side was mentioned only twice (Java Servlets on Tomcat software, and ASP.Net). Information about the programming language used on the client was available for all but seven of the systems, and were: C++ (3), Java (2), Visual Basic (2), C# (1) and Flash (1). One of the systems used both Flash and C++.

Mobile devices were used as learning tools in all but one of the systems. Explicitly mentioned types of mobile devices were Tablet PCs (2), PDAs (6) and mobile phones (3). Based on this information we can conclude that PDAs may be currently the most popular client type in pervasive learning environments. However, due to the recent convergence of mobile phones and PDA devices, both device types could be used for the same purpose. Tablet PCs are somewhat clumsy for pervasive learning in systems where high mobility is required. We established different roles of mobile devices based on the extracted information, and these roles are presented in Table 4 together with their frequencies and descriptions. Frequency denotes how many times a role was present in the reviewed systems, and it is worth noticing that in one system a mobile device can have several roles, but none of the systems supported all five. One system used a mobile device as an auxiliary tool for reading RFID tags, but users were also able to use the system without a mobile device.

Role of a mobile device	***f***	***Description***
Data collection tool	5	Users collect data from the environment by using information capturing features of the device such as a camera (still and video images). Captured data can be processed further by the system or stored as a trace of learning activities, for example.
Content representation tool	13	The high frequency indicates that this is probably the most important role of mobile devices in pervasive learning systems. In this role, mobile devices are used to view context-sensitive content provided by the system. The format of the content represented on mobile devices in the reviewed systems was text, image, audio or video.
Communication tool	4	In some of the systems mobile devices were utilised to establish communication between users of the system. The forms of communication are explained in Observation 4.
Navigation tool	2	Mobile devices were used for navigation; with the help of the device a user is able to know his/her own location or a location of a specific object within the environment. In the reviewed systems, the navigation feature was either based on GPS or RFID.
Notice receiving tool	2	In two systems, different types of announcements and notices were delivered to users' mobile devices, such as reminders and announcements submitted by the teacher.

Table 4. Roles of mobile devices in pervasive learning environments

Observation 4

Most of the reviewed systems were built to support multiple users. We consider two different aspects of a multi-user system: the first aspect is support for multiple simultaneous users, and the second aspect is system mediation of communication between users. In other words, a system can support multiple simultaneous users without providing methods for communication, or it can support communication among users by some means. Twelve of the fifteen reviewed systems supported multiple simultaneous users, however, this data could not be extracted from all the papers. The number of systems providing communication tools for users was only six. Communication between users was either physical (2) or virtual (4). We considered as physical communication only those cases in which the communication by conversation or other physical means was explicitly mentioned as a part of the learning experience. Some of the systems allow both virtual and physical communication if the users share the same location and time. The systems providing tools for virtual communication utilised one or several of the following methods: forum, chat, SMS, instant messaging and content sharing. It is notable that none of the systems used audio or video communication even though particularly audio communication would be natural for mobile devices.

Observation 5

The roles of the physical environment had some variation but in general three different roles were recognisable, albeit not explicitly presented. These roles and their respective frequencies were: *context for learning* (9) *content for learning* (7), and *system resource* (3). It is worth noticing that in one system an environment can have multiple roles. For example, there were five cases where the environment was both context and content for learning. Additionally, two of the reviewed systems, an interactive sensor board for museums (Kusunoki *et al.,* 2002) and an interactive toy set for children (Lampe and Hinske, 2007), did not utilise the environment, and one paper did not state the role of the environment at all. Environment is a *context for learning* when learning is situation-based and the system adapts according to situations and contexts in which the user is present. This is also called contextual or situational learning. The environment provides *content for learning* when the system utilises the information within the environment as a learning resource. Finally, environment is a *system resource* when some objects within the environment are triggers for system events (e.g. furniture with embedded sensors which trigger usage events (Beaudin *et al.,* 2007)).

DISCUSSION

The evidence presented in Observation 1 suggests that RFID is the most prevalent sensor technology used in pervasive learning environments, in part due relatively cheap price of RFID tags (approx. 1€ each in the authors' countries) and readers (150€), compared to the cost of a basic wireless sensor node of at least 300€. RFID readers are already available in some mobile devices as integrated chips, including models by Nokia and Samsung, and we expect that RFID will become a mainstream technology in mobile devices within 5 years. This development will enable tagging any object in a pervasive learning environment, thus making the underlying system more aware of the environment.

Observation 2 identifies several suitable learning models, however these require proper validation and comparison. Many of the proposed learning models were not validated, and those that were did not provide reliable results, as the test scenarios were inadequate in terms of the numbers of test participants and repetitions. It was discouraging to discover that only a handful of papers *explicitly* discussed learning models, and this leads us to believe that the authors of the other papers either did not consider learning models at all or did not include that information. All the learning models followed an informal constructivist approach. Authentic learning was mentioned more than once, thus suggesting its potentiality for pervasive learning. Nevertheless, the results of the observation 2 indicate that in this field learning model validations are required before any of the models can be seriously recommended.

Observation 3 concentrated on technical implementations of pervasive learning environments and roles of mobile devices in them. The use of client-server architectures in most of the systems shows that centralised control is used in preference to a distributed system. The benefits of using a centralised approach are the ease of installation and maintenance. However, a distributed system consisting of autonomous sensor nodes and one or more coordinating servers would be more fault-tolerant and load-balanced. Fault tolerance is particularly important in large systems which are running constantly and have hundreds or thousands of resources. The systems presented in the reviewed papers were quite small, thus the absence of distributed control is justified.

Popularity of PDA devices (6) as clients over Tablet PCs (2) and mobile phones (3) can be explained with screen size, physical dimensions, and processing capabilities. Displays on mobile phones are often too small for viewing information other than text and low quality images/video. On the other hand, Tablet PCs have large displays, but they are more difficult to carry around due to their large physical size. PDA devices often have larger displays than mobile phones and their size is smaller than that of Tablet PCs. Moreover, PDA devices have enough processing power for handling basic media types, while the resources are often more limited on mobile phones. Despite the popularity of PDA devices, mobile phone and PDA technologies have been converging, and there is a similar trend of convergence going on between laptops and mobile phones/PDAs. These new devices are called Ultra Mobile PCs (UMPCs) and their size is smaller than Tablet PCs, but bigger than mobile phones or PDAs. In addition to being highly portable, UMPC devices are capable of running a full-scale Windows XP operating system or equivalent Linux distribution, thus making them suitable client devices for various software solutions supporting pervasive learning activities. Currently the problems of UMPCs are high price and relatively short battery life. However, we can expect these aspects to improve in the near future.

According to observation 3, there were five types of roles for mobile devices in the reviewed systems: data collection tool, content representation tool, communication tool, navigation tool and notice receiving tool. Since the content representation tool was the only role having a frequency more than 10, many of the systems merely concentrated on providing context-sensitive content to the user. This indicates that there is work to be done to increase interaction between the environment and the users, as well as among the users. For example, the data gathered with a data collection tool can be saved and processed later to continue the learning experience at another location, e.g. at home or in a classroom. As another example, communication with peers can help users to establish and strengthen social relationships.

Observation 4 concluded that only a few pervasive learning environments are truly multi-user systems through supporting communication among users. The lack of voice- and video-based communication was also noted, and we suggest that a reason may be the requirement for other running applications to be closed before using mobile phones' built-in voice call capabilities. Furthermore, creating a new VoIP (Voice Over IP) application is not a trivial task. Audio/video-based communication is more personal, instant and effective than forums or chats. If a pervasive learning environment is to be built on a principle of virtual collaboration, using instant communication is possibly a good way to implement it. An alternative method is to provide a meeting request tool for the users through which two or more users could meet physically after agreeing on it virtually. This kind of approach was used by Laine *et al.* (2007) where two users of the system met physically after one user had sent a help request to another user.

In Observation 5, we distinguished three different roles for the physical environment in pervasive learning systems: context for learning, content for learning and system resource, and the frequency figures (9, 7 and 3, respectively) indicate that context and content are used most often. Usage of the environment as a system resource would be higher if more systems would embed wireless sensor networking components for sensing different aspects of the environment. The low frequency of the system resource role is related to the lack of interaction with the environment; if the system would be able to closely observe user's behaviour and the state of the physical environment, the system would become more responsive and adaptive. This would in turn encourage users to interact more with the environment by using different objects and observing the consequences on the mobile device or in the physical environment.

CONCLUSION

We have reviewed 15 pervasive learning environments by concentrating on their underlying technology, suitable learning models, and roles of mobile devices. From the technological perspective, the majority of the systems used client-server architectures using mobile device clients, suggesting centralised control. The most popular client mobile devices were PDAs, and RFID was the most used sensor technology, partly due to its cheap cost compared to other sensor types. The most popular roles of the mobile devices were as a content representation tool and a data collection tool. We concluded that there is still work to be done in order to utilise the capacity of mobile devices to the full extent. Three different roles for the physical environment were identified: context for learning, content for learning, and system resource. From the point of view of learning models, the reviewed systems implicitly or explicitly suggested several constructivist models to be suitable for pervasive learning environments, in which authentic context is in a central position. However, the the suggested learning models were insufficiently validated, and this is an area for future investigation.

As a future activity, we intend to use the results of this survey to design and build a flexible pervasive mobile learning environment that uses not only RFID, but also wireless sensor nodes, auxiliary input/output devices, mobile devices and intelligent agents. We will build this system modularly in a way that will be easy to adapt to different environments such as museums, schools, fairs, amusement parks, art houses and companies. We will use the system to investigate how different learning models can be efficiently applied in pervasive learning environments and what are the critical features of such environments.

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Podcasting and Learning Experiences: User-centred Requirements Gathering

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ABSTRACT

In late-2007, at the Open University, UK, we launched a research initiative to investigate the role of podcasting in distance education. To ensure the success of the research initiative and uptake of the research outcomes, we followed a user-centred design approach which meant involving key stakeholders (educators and students) in early requirements elicitation. As a part of this initiative, we conducted online surveys, e-mail questionnaires, a series of workshops and interviews to elicit students and educators' perceptions of podcasts: how podcasts could support their learning and teaching. In this paper, we report the analysis of one of our requirements elicitation tools, the e-mail questionnaire which we sent around within the University in early 2008. The collated data pertains to students' and educators' perceptions on the following aspects: how course-related podcasts could improve the learning experience?; topics in the course(s) they are associated with and which would benefit from being presented as podcasts and say why you think these topics would be good choices; and (c) any potential drawbacks with introducing podcasts and do you have any thoughts on how these might be avoided?. These insights from our students and colleagues reported in this paper can help inform and guide the introduction and production of podcasts on courses in distance-education. This paper would be of interest to course designers, facilitators, staff developers and policy makers who are involved in integrating podcasts within the curriculum of their programmes and institutions.

Author Keywords

learning experience; mobile learning; podcasts; podcasting; portable media players; vodcasts.

BACKGROUND

A podcast is an audio or video file that is made available over the Internet and which can be subscribed to and downloaded automatically each time an update becomes available and then played at a time that suits the user on their PC, PDA, mobile phone or via a portable music device (e.g. Boulos, *et al*., 2006) There is a common misconception that podcasts require to be listened to on a mobile MP3 player (Maag, 2006) this is not the case and podcasts are easily accessible from a PC using freely available software such as Apple iTunes. Copley (2007) highlights that podcasts are media files that are distributed to users via syndication feeds (RSS/Atom); new episodes are downloaded automatically to the subscribers of the podcasts. Bongey, *et al.* (2006) state that this automatic distribution has been the key reason for podcast success and it is this automatic distribution that makes podcasts distinct from standard audio files.

The generally recognised founder of podcasts, Adam Curry, had two main objectives: podcasts should be made available like e-mail, and not streamed which is slow and unreliable; and content should be downloaded to a personal device so that it is available anytime (Hargis and Wilson, 2005). Where podcasts include a visual element, for example, lecture slides, or a video of the lecturer talking through the presentation, or clips of some illustrations and simulations, they are known as VODcasts (video on demand broadcasting) (Kajewski, 2007). Podcasting is the term associated with the actual production of podcasts themselves and this derives from generic use of the Apple iPod (Cebeci and Tekdal, 2006) to play these files – the term actually combines 'iPod' the device, with 'broadcasting', the process of recording audio for the device (Bennett, 2006).

The popularity of devices such as iPods and other MP3 players amongst the students for music and even listening to podcasts available on the Web, poses fewer challenges of introducing podcasts in education. Several universities have introduced podcasts – for example, Duke University, University of California, University of Sheffield, and Mansfield University. Outside the classroom, podcasts are being used for various purposes in Universities: for example, to support induction processes in a University; making students aware of student life issues in a new University to deliver university-wide messages regarding campus activities; and announcements of research activities. The main applications identified in the literature relating to the use of podcasts by educators highlight three key roles: provide lecture material; provide pre-class listening material/extended course material; and offer feedback on coursework. Further, academics are finding it easier to produce podcasts due to the availability of information (guidelines) on the Web and access to the technology. For example, a computer with in-built microphone and speakers is sufficient for producing podcasts in most contexts. Open source software such as Audacity can support the recording and editing of podcasts. In addition to the academics, students are being encouraged to create podcasts and vodcasts. Student-created podcasts include interviews amongst students about a course-related concept; reflections on the course or on a field trip; or recording critiques of one another's work.

The use of audio in an educational setting has been used widely over many years particularly in distance education environments (e.g. as discussed in Edirisingha, et al., 2007.) Research carried out in the 1980s (Dunbridge, 1984, as reported in Williams, et al., 2004) proved audio to be an effective tool for distance learners who can generally feel isolated. Students prefer audio because they like responding to sound; hearing the voice of their educator or course designers; listening to interviews/debates; hearing from experts in their field; and being encouraged by hearing the voice of someone they know. Audio-only activity helps the student to focus on the auditory channel and is a useful medium in terms of material covered. However, it requires a considerable feat of memory to sustain an understanding of the full meaning until it can be reflected upon and tied to other activities at a later stage (Laurillard, 2002). For example, students could be asked to listen to a podcast and then the questions related to the podcast could be raised in the forum for discussion and personal notes or thoughts could be recorded in students' personal blogs. This mix of technologies and activities could help to reinforce the audio content and provide opportunities for collaborative learning. Further, audiovision could be a more acceptable medium in which the auditory channel will be combined with the visual channel to focus on. For example, printed text (Dunbridge, 1984) or pictures, illustrations, video clips, or icons in a vodcast could accompany the audio materials. For example, an instructor of a technology course could talk through visuals/video how the debugging of a computer program can be carried out or a student could talk about his field trip while playing the video of the scenes captured in a vodcast.

Chan and Lee (2007) identify that audio has been neglected in recent times and that the rise in availability of mobile technologies and the widespread availability of broadband is reversing this situation. Podcasting is a natural extension to traditional audio learning material and it has the added benefit of being a "push" technology with one subscription taking care of multiple downloads of related materials/episodes. This makes it an easy to use technology that requires very little intervention by the student to access podcasts and very limited work for the educator to upload a single file that can be guaranteed to be made available automatically to the complete cohort.

At the Open University (OU) in the UK, since its inception in 1969, there has always been use of multiple media to support distance students and audio has played a key role through TV programmes, radio, cassettes, CDs and now DVDs. Audio may be more motivating than print alone, and together with print may form a powerful alternative and aid to reading alone (Newby *et al*., 2000). Audio via CDs and DVDs have been known to aid recall, help retention, and lead to concept formation and higher-order thinking. However CDs and DVDs are one-way technologies (non-interactive, like a lecture) and the content may not be updated often. With the adoption of the VLE environment at the OU in 2006 and with the introduction of collaborative environments such as blogs and wikis and with the development of a podcast module within the VLE, there has been a growth in interest in podcasting amongst the educators. In late-2007, we launched a research initiative to gather requirements of podcasting from our students and the educators. The success of any system (computer-based or otherwise) or new technology must involve all stakeholders in early requirements elicitation and throughout the design and development process (Sears and Jacko, 2007). It is in this spirit of being user-centred, we have carried out this research initiative on podcasting at the OU and involved the key stakeholders: students and educators. As a part of this initiative, we have conducted online surveys, e-mail questionnaires, a series of workshops and interviews to elicit students and educators' perceptions of podcasts - how podcasts could support their learning and teaching. In this paper, we report the analysis of one of our requirements elicitation tools, the e-mail questionnaire which we sent around within the University early this year.

THEORY

According to Ertmer and Newby (1993), the three schools of thought - behaviourism, cognitive psychology and constructivism can be used as taxonomy for design of online learning environments. The cognitive psychology view is particularly relevant for audio materials. Cognitive psychology looks at learning from an information processing point of view, where the learner uses different types of memory during learning. Learners use their sensory systems to register the information in the form of sensations. Sensations are received through the senses into the sensory store before processing occurs (Anderson and Elloumi, 2004). The information persists in the sensory store for less than one second (Kalat, 2002); if it is not transferred to working memory immediately, it is lost. Strategies should be used to facilitate maximum sensation and allow learners to perceive and attend to the information so that it can be transferred to working memory. One such strategy is employing audio, visuals, animations and video within learning materials (Anderson and Elloumi, 2004). Audio cassettes and then CDs and DVDs have long been recognised to support learning, particularly for lifelong learners, whose study can be done in parallel with other necessary activities such as travel, gardening, shopping and ironing.

The theory of connectivism is particularly relevant for podcasting. In connectivism, learning is seen as being lifelong, a continual process where technology is used to define and shape our thinking and where many of the previous theories of learning can be replaced or supported by technology. This theory asserts that learners learn more from plugging into existing networks of information and where cognition and emotions influence and affect meaning-making. The ultimate goal of connectivism is to have current up to date, subject specific, knowledge (connectivism.ca, 2008; Mayer and

Moreno, 2004.) The immediacy and pervasiveness of podcasting with their real-time ability to provide instructional content and where cognition and emotion are used in terms of the mobility and flexibility offered by a mobile device has synergy with connectivism. Further, Vygotsky (1978) drew attention to the strong links between the culture and social influences upon the learner, and their relationship with the learner's cognitive development. Given that many students in schools and higher education today already have access to a portable music player, it would appear to make sense (at least from a motivational point-of-view) that the potential of using such players for goals which are more explicitly linked to the curriculum be at least explored.

Kukulska-Hume and Traxler (2008) discuss how mobile learning can support a variety of learning activities and theories. Applying their categories of activities and types of learning, podcasting can support different theories of learning. For example, a podcast by an instructor which gives feedback or has a reinforcement element supports *behaviourist-type* activity. For a s*ituated activity*, learners can listen to a podcast in an authentic context, or use it to access information while moving around an environment in a specially equipped location such as the museum. For *collaborative learning*, podcasts provide an easy means for information sharing and communication between learners.

Laurillard (1995) states that audio/video materials are not inherently discursive, in the sense of an educator not being able to comment of the students' meanings and understanding of the audio/video materials. Therefore, the audio/video materials as podcasts or vodcasts which actually help to reduce social distance in distance –learning (Nicol, *et al.*, 2003), can be followed by activities and discussions with educators and fellow-students in asynchronous environments such as blogs, wikis and forums, or in synchronous environments such as in a 3-D virtual world (e.g. Second Life). A 3-D virtual world can help provide the virtual proximity and sense of visual presence, and enable synchronous communications through avatar-based communication. Socialisation and discussions in 3-D virtual worlds after listening/viewing of audio-video materials via podcasts/vodcasts could help foster socio-constructivist and collaborative learning (Irwin & Berge, 2006; Minocha and Roberts, *under review*).

In the next section, we discuss how we elicited and analysed students' and educators perceptions of podcasts at the Open University in the UK.

METHOD

The Open University has some distinct ways of working. Learning is done largely by correspondence. High quality materials are developed by a central academic staff, who are organised by faculty into Course Teams with responsibility for producing teaching materials which are delivered by a much larger body of associate lecturers (hereafter referred to as tutors). Tutors provide some limited face-to-face tuition, on courses where student numbers allow this, along with support in the form of feedback on assignments, telephone and email contact. As the University serves an international student base, some courses have geographically more dispersed tutor groups, so face-to-face tuition is not always feasible.

We used a simple email questionnaire containing three open-ended questions in order to

i. ascertain the level of interest in the use of podcasts from potential producers and consumers
ii. ascertain general or specific areas in which they might help the learning process
iii. bring to light any potential resistance to their use
iv. elicit the requirements that both producers and consumers would expect to see in specific situations
v. make potential producers aware of the possibilities
vi. encourage 'buy-in' from the producer stakeholders

Some of these objectives were explicit in the questionnaire; others were a little more oblique. The questionnaire was sent to central academic staff, students and tutors, with only minor differences in wording to reflect the differing roles of the respondents.

The wording of the three questions was kept open-ended in order to allow the respondents more room to express their own opinions and not be guided too much by the nature of the questions themselves. They were based on the following:

- In what ways do you think that course-related podcasts could improve the learning experience?
- Suggest topics in the course(s) that you are currently studying, teaching or working on which would benefit from being presented as podcasts and say why you think these topics would be good choices.
- Are there any potential drawbacks with introducing podcasts and do you have any thoughts on how these might be avoided?

It is well known (e.g. http://www.cja-jca.org/cgi/content/abstract/51/5/449 or http://tinyurl.com/5h2h8p last accessed 28th July 2008) that questionnaires emailed to multiple recipients often generate a poor response, possibly because each recipient assumes that their own reply will not be missed or that it would not be necessary to reply. In order to encourage as many responses as possible from the central academic staff, which would be largely responsible for the production of podcasts and so were important stakeholders, a 'prize draw' was proposed, with an iPod player as the prize, to be given to a responder chosen randomly. This suggestion obviously needed to be cleared by the University's Ethics Committee, although it still aroused the ire of one respondent who regarded the offer of such an inducement to be encouraging gambling. The prize draw was associated with a cut-off date in order to ensure a reasonable time in which to produce responses.

The open-ended nature of the questions meant that the analysis of the responses could not be automated, which necessitated a fair amount of manual effort, sifting those responses which simply repeated comments already made and adding new points to an ever-growing list, which eventually produced a summary report of some 12 pages (including appendices). We received 77 responses, of which only 3 were not positive. One regarded the podcast as no different from the recordings we had made in the past and the third had no comments to make. Because a number of OU mailing lists were used in sending out the questionnaire we have no real idea of the number of non-respondents, but the comments received are nevertheless very valuable and it was not our intention to produce any statistical analysis. Many of the positive responses were simply supportive comments, but there were also a great number of useful comments and suggestions which we have summarised below.

CONTRIBUTION

The respondents to our survey included central academic staff, tutors who are generally part-time employees and have other jobs in industry or academia, and students who are also part-time, and generally in work at the same time as studying with us. In each of these three constituencies we had some respondents with no experience of podcasts, some with experience of listening to them, whether for learning or for entertainment, and some with experience of creating them. In the following we have made no effort to distinguish the experience level of the commentators. In many cases the same points were made by people with very different backgrounds. However, it can be seen that some of these statements may have been made by people with limited or no actual experience and so further research would be required to determine their truth or otherwise.

A particular challenge in summarising the responses has been the different interpretations that people have as to what constitutes a 'podcast' – it is important to distinguish the types of media that different respondents were considering:

- **Podcast**: a purely audio presentation delivered automatically to a student's computer via the internet, capable of being listened to on a portable device; possibly accompanied by a printed or printable script and/or slides. Similar to a radio program or some of the recorded material we have used in the past, with a different method of delivery.
- **Vidcast** or **Vodcast**: as above but including visual material, whether talking over a slide presentation or showing video. Again, similar to the video material we have previously produced.
- **Screencast**: as above, but with the visual content usually being screenshots or animations of actions carried out on a computer.

The basic podcast is capable of being copied to a quite cheap MP3 player for simple listening on the move. The other types of presentation need a more expensive portable device (with a screen) or must be viewed on a computer.

The questionnaire was in three parts asking how the respondents thought that podcasts could improve the learning experience, what specific topics could be covered and what problems could be foreseen. We will discuss each in turn.

Responses to part (a)

Part (a) of the questionnaire asked "In what ways do you think that course-related podcasts could improve the learning experience?" A number of consistent themes arose in response to this question, both from students and staff who believed that the podcast could be very useful for:

Presenting updates or discussions of current interest: For example, a student said: "*They [podcasts] could support topicality breaking out from fixed text to show something relevant happening now, for instance an engineering analysis of the recent Heathrow no engines plane crash*." A staff member stated: "[podcast] *could be a debate on a hot current issue between two parties with differing views*."

Other themes relate to the use of audio along with printed and other text-based materials in distance-education and to support students' varying learning styles: providing a 'change of pace'; giving the 'received pronunciation' of technical terms, names, etc.; clarifying meaning through the use of stress/intonation; catering for students with different learning styles; and repeated listening to material that essentially needs to be memorised. Some students perceived podcasts as recordings of face-to-face tutorials for those students who are unable to attend.

The themes which emerged from the staff data related to how podcasts could support the pedagogy of the course: for instance, using podcasts to present discussions between academics and practitioners in a field; introducing more 'esoteric' aspects of the course; or as support mechanisms for the course content which may otherwise be in print or delivered face-to-face.

Vodcasts or screencasts were perceived to be useful for:

- seeing things being done, e.g. physical demonstrations of using equipment, etc.
- providing support for topics that involve drawing diagrams (UML, entity-relationship diagrams etc.)

One student was particularly keen to see podcasts introduced, having had some previous experience of them where, *"The presenter's excitement about the subject was contagious - it really did make me want to look in further detail at what was being discussed.*"

Podcasts were perceived to be advantageous to support learning and teaching. The key advantages highlighted were: the technical ease of producing podcasts with minimal training for most educators; and the regularity with which they can be delivered to students on current issues related to the course. One staff member said: "*the main differences between 'normal' audios and podcasts are not for students but for production. The production values of a podcast might be lower, and therefore can be produced more quickly and cheaply. Quick production means that materials which are very current can be brought into the course more quickly and abandoned more quickly as well.*"

Our participants stated main advantages:

- Can be produced reasonably quickly in response to current issues
- Live presentation is almost inevitably more attention grabbing than reading
- A more personal and intimate way of communicating from the Course Team
- Could reduce the feeling of isolation for distance learners; the automated (e.g. via RSS feeds) and regular delivery of podcasts, is itself seen as a benefit and a means of communication between the students and the institution: "*although most likely automated, they [podcasts] do form part of the continuous communication with students.*".
- Students can adapt materials, by playing it slowly, for instance for language learning, or by editing a version with missing words to test their re-call
- Regularity of contact; prompting students to engage with the course on an ongoing basis.

The podcasts were perceived as "*playing a part in creating a sense of community and engagement.*" For example, one staff member said: *"the podcast could also be used to hook into other related media (e.g. discussion forums) for further discussion, generating increased traffic which will in turn generate further response/content for students to engage with.*" A podcast on a course-related current topic of interest could, therefore, be used in conjunction with other tools on the course such as blogs, forums or wikis for discussion or for conducting activities related to the content of the podcast.

Responses to part (b)

Part (b) of the questionnaire asked, "Suggest topics in the course(s) that you are currently studying, teaching or working on which would benefit from being presented as podcasts and say why you think these topics would be good choices."

In the response to part (b), some of the themes of part (a) including timeliness of the podcasts; support mechanisms for other course media; and as a way to feel connected with the course team in a distance-education environment were reiterated. A number of general points were suggested:

1. They [podcasts] might be used to start off an online discussion, to get a debate going on some controversial issue. For example, a staff member said: "*the tutor could make some highly emotional statement (taking advantage of the fact that audio can perhaps communicate emotion more effectively than text on its own)*."
2. They could be used to discuss current events, new research or public news items
3. They could be used in relation to skills development, student retention and careers work
4. They could be a good way to give a sense of Programme identity, and provide some continuity between courses. There is no reason why a podcast needs to be course specific, it could be aimed at a generic subject area possibly with its own associated forum to be able to discuss further any points it brings up
5. They could be used as part of a student retention strategy, to encourage students with revision before exams and with ideas for preparation of assignments.

And a number of topics were suggested that apply to more than one course:

- Exam technique, writing, literature reviews and other learning skills
- Research and presentation of research projects
- Drawing and interpreting complex diagrams of all kinds

- Revision of key technical terms, concepts and ideas for repeated use in preparation for exam
- Dramatisations and readings of poems
- Pronunciation (foreign names and technical terms: A colleague from the Department of Languages commented: "*I am currently involved in a language course, and I feel that podcasts would allow another opportunity for students to see a speaker's body language or to hear a native reflection.*"

For courses which have a visual element such as the Human-Computer Interaction (HCI course) course, or the programming courses, or the courses related to Environment and Sustainability, both the students and staff members mentioned that the visual aspects such as examples of user interface or product designs in the HCI or a design course, or the programming concepts demonstrated with a voice over, and podcasts related current issues such as social policy changes or on climate change will provide alternative views on key issues of the courses.

Responses to part (c)

Our final question was "Are there any potential drawbacks with introducing podcasts and do you have any thoughts on how these might be avoided?"

There were concerns too about the additional workload due to podcasts – specifically, if podcasts are introduced on current courses. A staff member expressed concern: "*my guess would be that students would NOT appreciate 'extra stuff' but rather would want focussed assistance, despite academics' desire to extend and develop course ideas.*"

A number of practical concerns in the categories of social, technological and pedagogical concerns were raised by our students and colleagues:

Social concerns: multi-cultural, age and language differences; students with hearing problems (accessibility issues); students not having the inclination or opportunities to listen; and the concern that podcasts could increase the "digital divide" between those comfortable with the technology and those not.

Technological concerns: students with only dial-up access having to regularly download large files; limitations of the equipment (e.g. small screen); and the students may not have the necessary equipment or skills.

Pedagogical concerns: student resistance to 'extra work'; and possible problems for students in prison (some students of the OU are based in prisons) who may not have access to the web or portable players.

Then there were a number of concerns about the value to the student: for example, podcasts may require less engagement so could lead to a false sense of accomplishment; reading is generally quicker than listening; and finally podcasts could become seen as an alternative to face-to-face contact and, therefore, the attendance at the face-to-face tutorials may deteriorate.

There were also some concerns over the quality of the produced material:

- Bland presentation and no feel of enthusiasm do little to help the learning process
- Low quality productions might harm the image (or the brand) of the University
- Passes out of date or requires regular updating
- Quickly produced material might be inconsistent with the existing material or use different terminology

And there were concerns about the involvement of tutors:

- Some tutors will use podcasts and others not; therefore, some students will benefit and others not
- Centrally delivered podcasts by course teams might be seen as threatening the tutor's role

Some suggestions for avoiding problems included:

- Avoid introducing new learning – use to reinforce or repeat teaching delivered 'normally'
- Consider making the podcasts optional
- Always provide a transcript for students to mark up and as an alternative
- Consider the trade-off between immediacy and quality – some material benefits more from being up-to-the-minute, without needing lots of development, other material should be given more production time.
- Use a 'conversational' approach, rather than lecturing
- Podcasts should be tied to specific learning objectives
- There should also be known organisational objectives such as maintaining engagement, improved results, retention

- Make clear what each podcast contains and how the student will benefit from it
- Use enthusiastic speakers with good communication skills

General Comments

In addition to answering our specific questions a number of respondents provided more general comments. The following are only lightly edited from the originals

- A range of lengths were suggested, ranging from 5 to 30 minutes
- It would be possible to involve students or 'service users' in discussing the course material or the learning experience in general; possibly even making the production of a podcast part of the course assessment.
- Different media could be used in concert, e.g. by linking a podcast to a forum or a wiki where its contents could be discussed.

These insights from our students and colleagues discussed in this section can help inform and guide the introduction and production of podcasts on courses.

EVALUATION

Despite the fact that email questionnaires notoriously produce poor returns, 77 responses were received, which forms a substantial amount of input and would have required a great deal of time and expense to acquire via interviews/focus groups. Further, in an interview, or a focus group, there can be fewer opportunities to reflect on the questions and the visual and social cues such as body language, facial expressions, and so on can affect or bias the opinions and conversations. In contrast, the method that we followed of sending some questions by e-mail was simple, not very resource-intensive but yet enabled participants to contribute and reflect on their views and thoughts in their own time.

There are several follow-on activities that we are involved with and will be pursuing this year: interviewing some of the respondents of this e-mail questionnaire depending on their availability and willingness to participate in interviews; and we are conducting a series of workshops in our University to bring colleagues from across different disciplines in the University to discuss the role of podcasts in teaching and learning in distance education. The workshops have involved group discussions on the following themes: (a) pedagogical rationale for educational podcasting; (b) how podcasts could be integrated within existing course materials, or used in conjunction with existing materials on a course; and (c) how podcasts could be used in conjunction with other VLE tools such as forums, blogs and wikis. Based on our empirical investigations, we are designing and introducing podcasts on a few courses at the OU. Evaluations through interviews, reflective questions and course-work based on the podcasts will help to investigate the pedagogical effectiveness of podcasts.

CONCLUSIONS

In the podcasting research project discussed here, we have been user-centred – focussing on the requirements of the key stakeholders and involving them. In previous projects in the VLE programme at the OU, we have interacted with educators and students early on in the process of introducing any new e-learning tool. These interactions have been via focus groups, discussions, newsletters, and, so on. Consequently, the uptake of various VLE tools has generally been positive and even when some obstacles have arisen as it can happen when new technologies are introduced, the students and other stakeholders have been supportive (Minocha & Roberts, *in press*).

As far as the research in podcasting is concerned, this is the first study that we are aware of which has investigated the perceptions and requirements of the educators and learners. The various podcasting initiatives in the literature concern the creation and introduction of podcasts by educators or students and their evaluation. The empirical data in our study has provided useful guidelines for the design of podcasts, the situations in which they won't be advantageous, the constraints, and the ways in which the podcasts could be useful. The characteristics of timeliness of podcasts, the ease with which they can be created, uploaded and downloaded are the obvious advantages that have been cited by the participants. The data also shows that podcasts could also be used in conjunction with other tools such as forums, blogs and wikis. For example, after listening to a podcast, the students could discuss it on a forum or on a group-blog.

However, even with the ease with which the podcasts can be created, uploaded and downloaded, our research has shown that there are some pedagogical factors that will help influence the learning experience of students. These factors relate to: integration of podcasts within the pedagogy of the course; direct link between the learning outcomes and the activities podcasts will support on the course; clarifying the role of the podcasts within the pedagogy of the course to the students; considering the requirements of tutors and students before and after the implementation in terms of staff-development and guidance/support documents; and ensuring that the podcast-related technology is usable by conducting user-based evaluations before the technology is deployed. The empirical data presented in this paper will help guide educators towards integrating and designing podcasts to meet the learning outcomes of the course.

With the popularity of blended solutions in online and mobile learning, emphasis is being placed on determining the optimal combination of media, technologies and instructional approaches. More research is required to offer guidance in selection of means for audio-delivery – for example, as podcasts, or audio-conferencing, streaming video, radio, and so on. However, sound being a natural part of our lives and environment, it should be a natural part of education and audio technologies such as podcasts can not only support mobile learning but also entice, motivate, inform and reinforce.

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Accounted Learning: A WoLF-oriented Approach to Mobile learning

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ABSTRACT

This article concerns how Teaching Assistants (TA) on a foundation degree programme in education account for their mobile learning experience using a Moodle site and also from evidence embedded within their portfolios. We develop and establish a systematic elaboration of how the teaching assistants go about the business of gathering evidence through a narrative description of particular events and situations of using mobile devices. We try to also show the challenges they encounter of a personal, institutional and environment nature. We elaborating on features of mobile learning most appealing to our study cohort and discuss the likely appeal and analytical strength of an emerging framework to support mobile learning in the work-based context.

Author Keywords

Work based learning, learning design, leaner engagement, technical and social affordances of mobile learning, knowledge management, and organizational policies

INTRODUCTION

Over the last decade there has been growing interest in the pedagogical potential offered by handheld devices. Mobile learning, as this is now commonly known has grown as an extension of the elearning frontier from a minor research interest to a set of significant projects in schools, workplaces, museums, cities and rural areas around the world (Sharples, 2007). Some have argued that this wave of interest in the educational potential of handheld technology is a deliberate effort aimed at 'domesticating' mobile devices for educational purposes (Bachmair 2007. p. 106). Combined with web 2.0 technologies, mobile devices are also seen as offering new learning possibilities which represent a dynamic change in the strategies employed by learners and their production/consumption of learning products (Conole et al 2008). It has been noted that there is a dearth of studies looking specifically at students use of technologies and a failure to adequately acknowledge learners' perspective in the development of tools, pedagogy and teaching practices (Sharples et al 2005). Calls have also been made for studies that capture the diversity of how students are using technologies in formal studies as well as eliciting students' perspective of technologies (Canole et al 2008). The findings reported in this paper reflect the above concerns and provide systematic evaluation of evidence from a case study of how students use PDAs as personal learning management tools in a work based context and provide an account of this in their learning portfolios.

CONTEXT AND BACKGROUND OF WOLF

WoLF which stands for Work-based Learners in Further education is a collaborative mobile learning project between Leicester College and the University of Leicester (UoL) funded by JICS. The aim of the project is to investigate how Pocket PCs (PDA) can support the development of portfolios by Teaching Assistants (TAs) on a foundation degree programme in Education at University of Leicester. This accord with the vision of National Government and also the local East Midlands Learning and Skills Council. To this end WoLF is designed to achieve the following objectives transferable to similar learning contexts:

i. A Pedagogic Model and 'proof of concept' that can be reused and retried in different work-based learning contexts and disciplines
ii. Resources for practitioners for designing reflective learning activities using work-based learning scenarios of pocket PCs to capture evidence
iii. Guidelines for integrating the use of Pocket PCs into institutional VLEs within disciplinary and institutional specific contexts as part of e-learning strategies.

Unlike other work place learning schemes, learning for the foundation degree by Teaching Assistants occur in many different spaces, for example, in weekly face–to-face sessions with tutors; through practice and observation while at work; private studies at home, in learning resource centres and elsewhere. WoLF thus falls within the adult, work based, informal and lifelong approaches to learning and is underpinned by the notions of the autonomous and self directed learner who learns from experience of real world situation.

THEORETICAL BASIS OF WOLF.

Over the past decade there has been a growing body of literature on mobile learning. In what follows relevant literature from the wider body of existing research is highlighted to provide contextual background to this paper. Different writers have suggested how existing theories of learning could be applied to take advantage of mobile technology in the educational context. For example a review carried out by Naismith, Lonsdale, Vavoula, Sharples (2004) on mobile technologies has provided useful examples of how mobile technology can be deployed in the educational context from the theoretical lenses of the behaviourist, constructivist, situated and lifelong learning perspectives. In essay derived from a sociocognitive engineering design perspective Taylor, J et al (2006) have suggested a dialectical approach to mobile learning and have presented a task model base on this view. In a paper aimed at theorizing about mobile learning Sharples, Taylor, and Vivoula (2006) have also put forward a conversational framework of mobile learning. The value of their framework lies in the need to emphasise cultural factors such as control of the learning by the learner, the role of context and also communication. The work of Nyíri (2002) and Bachmair (2007) perhaps stand out in their attempt to show how a communication and everyday media use and learning could provide the basis for how mobile devices can impact positively on learning. Turning our attention from theoretical perspectives to issues of learning design, which is of relevance to this article, various studies exist whose findings are relevant to this paper. At a general level, the work of Laurillard (2008) on the London Pedagogy Planner, that of Conole et al (2008) from the JISC funded LXP project, that of Falconer et al (2007) base of Mod4L, and LADiE (2006) highlight important issues which are relevant to how mobile learning design could be characterized. For example the LPP offers the kind of blended learning designs lecturers need and also identifies issues relevant to modeling learning design. The Mod4L project provide examples of generic learning designs which can be applicable to mobile learning such as social-constructivist learning design, case based learning design, practice based learning design, reflective learning design, and cognitive scaffolding design. The value of the Mod4L designs is that it emphasizes the roles of both teachers and student in the design process. LADiE has put forward a reference model which addresses the questions of learning activity authoring and learning activity realization. Arguing for the need to rethink pedagogy for the Digital Age Beetham and Sharpe (2007) have maintained the need for learning design to investigate the needs of users and the modeling of solutions that best meet these needs. Shifting our attention to mobile learning specifically, the work of O’Malley et al (2003) has focused at the fine-grained issues in mobile learning, teaching and tutoring and put forward guidelines which directly address the question of pedagogically usefully learning activities that can be supported by mobiles technologies. Of particular interest to our study are the issues of cost, roles, support for teachers, services/applications and security and privacy. Addressing one of the “Big Issues” in mobile learning Milrad (2007) has also proposed a scenario based design for mobile learning that focuses on settings, actors, goals/objectives and actions and events. One question that has also captured the attention of mobile learning designers is the question of evaluation. The subject has been taken up by (Taylor 2007) and Vavoula (2008). Taylor has suggested that consideration be given in mobile learning evaluation to access to data, learner control, personalization, learner involvement in the design process and self evaluation of what counts as mobile learning. Recent work by Vavoula (2008) drawn from Myartspace (OOKL) project has highlighted challenges faced by mobile learners. She strongly argues for alternative measuring outcomes in mobile learning evaluation that focus on processes which indicate that learning may be happening set at three levels in three stages. Micro level evaluation focuses on the users’ experience of the technology (usability and utility factors), the meso level is focused on the users learning and educational experience i.e. cognitive learning, breakthroughs and breakdowns, and a micro level evaluation focused on organizational issues such as the impact on learning and teaching practice and sustainability. The three stages of the evaluation process are the design, implementation and deployment phases. Other related issues relevant to issues of learning design in mobile learning have been highlighted elsewhere. For example Stead (2006) has talked about personalization, adaptation, engagement, self evaluation and reflection; Winters (2007, p. 7 - 8) has drawn attention change in physical relations between teacher and learner, learner generated context, and learner generated understanding; Jones, Issroff & Scanlon (2007) have highlighted the affective issues, Becking et al (2004) profiling of learners, Walker (2007) learning conditions, Rainger (2005) accessibility and user control factors, and Kukulska-Hulme (2007) usability factors.o Specific case studies which reflect some of these issues can be found in the work of McFarlane, Roche and Triggs (2007), Rekkedal and Dye (2007), Kukulska-hulme and Traxler (2005), and Smith (2003). Taken together the above studies and critical essays suggest that there is growing evidence of the impact mobile devices can make on the ways in which students learn and highlights the nuances of the specific ways in which these devices are impacting on learners. What is also evident from the above is that there are differences in understanding held, emphasis on what should count with no consensus in sight. They also point to the many challenges faced both by practitioners and learners within this mobile learning habitat and the interlocking issues that characterize learning in the mobile age.

RESEARCH APPROACH AND DATA GATHERING METHODS

WoLF was designed to investigate work based learning mediated by mobile technology from a Higher

Education in Further Education perspective. We wanted to elicit an account - accounted learning - as we have dubbed it in our title of how Teaching Assistants go about their learning with the help of a PDA. WoLF was thus designed to answer the following research questions directly connected with the ability of Teaching Assistants to learn in a mobile fashion.

i. How do Pocket PCs open up opportunities for TAs to develop learning portfolios base on systematic recordings of classroom activities and reflection in practice?
ii. Secondly how do TA's integrate the varied learning activities that occur in different places by mapping learning in one space onto learning in other space?
iii. What challenges, if any, does the use of PDA present to Teaching Assistants?

We adopted an action research approach whose characteristics were deemed appropriate to the objectives of this project. As a research method, Action Research combines action and research with the intention of improving practice, focusing on practical issues identified by participants with the view of bringing about practical improvement, innovation and change of a social practice (Cohen, Manion and Morrison 2007). Its emphasis on progressive problem solving by involving people connected very much with the aim and objectives of this project. We followed a living theory approach of action research (Whiteheads and McNiffs 2006) as opposed to the participatory action research of the Paulo Freire common within international development. Data gathering were from two main sources following ethical guidelines:

i. Semi-structured interviews with TAs and project staff
ii. Secondly tracking TAs' use and knowledge sharing via the project moodle.

The combination of methods provided rich empirical accounts of user experience. The semi-structured interviews provided case studies of individual learners experience of mobile learning i.e. activities carried out, situations faced, challenges overcome and strategies devised for future use of the PDA. The project moodle was used to gain knowledge of the wider context of using the PDA and provided rich accounts of day to day events as they occurred, how the PDA impacted on the learning experience and what lessons were learnt which could be shared with other colleagues on the foundation degree programme. Sampling was based on purposive and opportunity sampling methods driven by the convenience of access to TAs registering for the University of Leicester Foundation Degree through Leicester College. Data analysis was carried out using Decision Explorer, a cognitive mapping software. As a data analysis tool, Decision Explorer supports a subjective view of knowledge in which individual beliefs, assertions; attitudes and values are considered valid and hence provide evidence for research (Ackermann, Eden, and Steve. 2004). The purpose of the analysis was to enable detailed modelling of the views, experiences and feelings of the research participants. The analysis also focused on generating individual maps of how, why, where and when the PDAs were used. It further identified emerging patterns of use within the dataset and categorized these patterns in relation to contextual factors.

KEY FINDINGS

Our findings show that there are different dimensions to the experiences of learner's when using mobile technology. Three broad overarching themes emerged from our data analysis which is discussed here. They fall under learning context / environment i.e. the situations/settings that generated learning activities; learning management i.e. how learning activities are planned, generated and shaped; and knowledge sharing i.e. how ideas and experiences are made available to others. At the end of each theme we identify the challenges faced, the interventions that were required or made and the perceived value / usefulness of a given outcome.

Learning context and environment

We found that TAs initially expressed positive feelings when first issued with the PDA. Many welcomed the possibility of using a PDA to enhance the learning experience and to support development of their portfolios.

- When I got it (PDA) I was quite excited

- i can find many reason of how it [PDA] will help me in my assignment

We also found that TAs' use of the PDA as a learning mediated device was characterized both in actual terms i.e. definitive use of the device and also in speculative terms i.e. contemplative use in the future. We found that actual usage of the PDA occurred mainly in the classroom and was driven mainly by practical activities with children. We also found that the majority of respondents' use of the PDA was linked to science based activities with children. We need to quickly point out that a likelihood exist that the focus on science subjects was not deliberate due to the fact that the interviews coincided with course work on "Technology and science".

- I have taken a couple of photos for the 4 to 5 weeks science experiment

- I have taken photos of them drawing skeleton

The main challenges which were reported when using the PDA in the classroom was the affordances of the social space and question about security of the device

- With work with children we are generally on the floor, kneeling down, bending over and it can slip out of my pocket.

A high proportion of what was reported as usage of the PDA was speculative in nature in terms of the potential of the PDA to help generate future learning activities.

- I want to start a 4 week experiment on growth, so I am going to grow plant and take photos of the process

- [Going shopping] I could just pull my PDA take some pictures of them [children] shopping,

A notable contextual factor which emerged was how the PDA compared with other devices made available to TAs within the school and home environments. Our study found that the PDAs compete with personal mobile phones, cameras, video recorders, interactive white boards and laptops.

- I still tend to use my laptop instead of using that

- we are used to using digital camera's and the digi blue visual recording

-I have tried the phone, and I do prefer my little phone because it's smaller

Accessibility issues were also mentioned as impacting negatively on the use of the PDA, including access to internet facilities at home, difficulty of installing software needed to synchronise PDAs with a PC, cost of connecting the PDA to the internet and time pressures both at school and home which inhibited use. For example on the home front some reported competition for access to home computers with other members of their family. Another factor which emerged was technophobia i.e. the perceived psychological difficulty of using the PDA.

-There is too much energy and strain. I don't need it [PDA]; I like to make my life simple

Technophobia raises questions about the psychological (pre)conditions of using mobile devices for learning. Respondents also pointed to a number of risk factors which affected effective use of the PDA. They include security of the PDA, cost of using it, fear of losing it, possibility of being attacked by thieves, and virus attack when synchronised to a PC. Of particular concern was the reported financial burden of having a piece of equipment which was not insured. (It was suggested to TAs to obtain insurance cover through their home insurance). A related factor was ownership of the PDAs which remained the property of Leicester College.

- For me I am a youngster, I don't really do insurance

- I have got enough insurance payment now I don't want another insurance

- to carry it is an extra thing because it doesn't belong to me you get scare

We also found that the processes and timing of recruitment had the potential of undermining commitment to use the PDA. Although TA's were not obliged to be part of the project if they so wish, they automatically joined the project when they enrolled for the foundation degree programme.

- to be honest and totally honest with you we didn't really asked for this [PDA].

Our data analysis also found that the skill profile of TAs divide into the technologically competent and the technologically incapable. This difference was found to be linked to past experience of using technology and to some limited extent age factors.

- I am seen as an IT mentor in my school (a younger TA)
- I don't really like to use IT, its time consuming, and brain consuming [middle aged TA];
- I still a little bit old fashioned

Personalization of the device for effective learning also became apparent. One user reported using the PDA as a phone, whilst another reported using the alarm function and also downloading personal music unto the PDA. Some TAs also speculated about using the PDA for recording lectures, managing assignments and maintaining contact information of friends and tutors. However we found no evidence to confirm use of the PDA for note taking. This could be attributed to non-availability of keyboards.

- I have been using mine as a phone

- I use the alarm….that was one of the first things I worked out

-I still write up quite a lot of my assignments in rough and the type up.

-Thinking about it if I want to I could use the dicta phone and record a lecture

- I can find many reasons of how it will help me in my assignment

The need to obtain ethical consent further emerged as a limiting factor on the extent to which the PDAs could be used within the school setting. A related factor was the question of public versus private spaces.

-I am not allowed to take pictures of any of my children because of the nature of my work

When brought together, we found that despite the perceived value of the PDA as a tool that can enhance learning in the mobile environment there were major challenges such as accessibility and motivation. What was perceived as a possible intervention to address these challenges was not too apparent. Not withstanding we found conclusive evidence to support the value or usefulness of the PDAs for managing contacts, assignment planning/submission, scheduling through the alarm and even managing shopping list.

Learning management and structure

The second set of evidence which emerged from our study regards how TAs went about the business of gathering and reflecting on evidence to support their learning. We found no consistent evidence which suggest that learning activities are structured in a manner that meets individual learning needs. Majority of reported learning opportunities and activities were driven by course modules and assignments pre-determined by the foundation degree programme in UoL. Hence there was no perceived need to formulate or initiate personalised learning objectives linked to activities, strategies and outcomes. We also found that learning occurred mainly through experimentation and was self initiated. Very little evidence emerged on formalised collaborative learning although some evidence was found about underground collaboration activities. Reflective learning was mentioned by some and was driven by the need to provide feedback to pupils, for example after a guided reading. We found no strong evidence that classroom learning was linked to other learning objects e.g. the web.

> … I am self taught. I think everything I have done is being through experience
>
> …I can just look at it again and it refreshes my memory
>
> I have used recording system where with done a guided read…I can refer to it when I am writing

In terms of the functionalities which were most preferred on the PDA for capturing evidence, majority of users reported using the photo and audio feature which were seen as having multi-sensory appeal. No evidence was found of using the word processing feature of the PDA. Non-use of the word processing functionality of the PDA was attributed to the non-availability of keyboard. Responsiveness i.e. the timing between the occurrence of an episode and grabbing of the PDA was reported to limit the effectiveness of using the PDA in the classroom. A related finding was classroom layout and constant reconfiguration. Further issues were reported about screen size and the fiddly nature of the stylus. This raises the question of whether the PDA is fit for purpose.

> - Mine, it's been only voice recording and photos that was quite easy
> - I have used it for videos and photos
> - I find it quite fiddling and small…I tend to use my laptop instead of using that [PDA]

In terms of access to learning resources respondents expressed frustration and anxiety about institutional policies, infrastructure and practices which undermined access to external resources. We found that physical access to resources occurred at two levels. Firstly access to resources preloaded unto the PDAs before they were issued. This included information on staff biography and details of each course module. The second level of access was via VLE i.e. the WoLF project Moodle which made available information on technical guidelines of how to use the PDA, module handbooks, assignment checklist, learning journal sheet, reflective journals, Teacher TV resources; booklets for example on learning to read and audio/video clips produced by fellow TAs. We found that although a lot of time and effort had been expended to produce these resources, institutional policies on ICT and existing infrastructure and services greatly limited access to these resources. For example in one school we found that there was only one computer, with dial-up facilities shared amongst over ten members. Although an assumption was made that all participants on the project would have access to PCs at home this was found not to be the case. Our conclusion was that there is a correlation between access to PCs and effective use of the PDA. Problems of installing the software for synching the PDA with the project moodle and the absence of wireless networks further added to the challenges faced of accessing resources remotely.

> - I couldn't access my hotmail accounts…there are certain things it won't let you do.
> - There is one [internet access]. The teachers use it, we have nothing to do with it.
> - I am looking forward to connecting it … and using the internet as well but i don't have wireless
> - I can't get the CD download on my computer at home,
> - I have one (computer) at home but it doesn't work, its not working at the moment

In terms of support to motivate effective use of the PDA, our participants reported that they relied on both formal and non-formal support structures. Formal support was mainly technical in nature and was provided by the learning technologist. The non-formal support came from familial sources such as husbands, children and cousins. Whilst it is difficult to assess the level of competence of these familial sources of support, our finding show the existence of parallel support structures i.e. institutional and domestic.

> - I have been in contact with [learning technologist] and she's helped me through
> - My cousin is in the IT business, and I have said to him sit down and teach me
> - If I struggle... my children would help me… my children are my teachers.

We conclude that learning management and structuring is rather classroom-centric and unstructured which makes it difficult to measure the specific ways in which the PDA impacts on the learning experience. We further concluded that ICT services/ policies inhibit the seamless flow of learning from one context to another. The combined effect of these challenges reflects a need for learning support interventions in terms of guidance for structuring individual learning. The possible benefit or value would be meaningful knowledge construction.

Knowledge sharing

Mobile learning relies on moving from one context to another as well as connectivity that facilitate synchronous and asynchronous communication which enhance knowledge generation and sharing. We found that the project Moodle provided one avenue by which this occurred. For example discussion forums, blogs and uploading stuff to the moodle site. We found evidence that individual video clips, and audio files have been uploaded by some

TAs on subjects such as magnets, ice balloon circuits, melting snow, and the sun moon and earth. On the face of it, it looks as if there was no sharing of knowledge outside the moodle environment. However we found two instances which suggest side stepping of the formal channels of knowledge sharing and private world sharing such as during tutorial sessions and social outing. No evidence was found to suggest sharing of portfolio and sharing using emails, text messages or using the creative potential of online communities such as face book and myspace.

- "XYZ took some pictures today and brought it in and showed the kids doing some skeleton
- In terms of using moodle; I can't use it at work, we are not allowed so I have not been using it at all.
- Its quite difficult to try and get the internet on

Taken together the major challenges which emerged as limiting knowledge sharing were personal cost, access to institutional VLEs and the internet in some home and school environments, and technical challenges of synching the PDA with a network PC. The potential value of the PDA for knowledge sharing was not lost on participants.

- I suppose transfer it from my PCs to here (PDA) for some one to look at I suppose I could use it for that
- [In my personal life] it can be a mobile phone, and texting and things like that

A major intervention is the need to address institutionally unfavourable policies that work against use of mobile technologies and empowerment of learning to use mlearning technologies in the formal learning enviornment.

DISCUSSION

From the evidence so far presented based on this study the following conclusions can be made.

- That the use of PDAs and thus mobile devices occur on a continuum of stages which then maps unto a continuum of cognitive/emotional states
- Three overarching stages emerged from our analysis which are learning management i.e. the need to gain control of learning tools, the learning context and the learning environment; meaning i.e. the process of generating ideas and constructing/ representation knowledge; and thirdly the need for the creation of mobs following Urry (2007 p. 8) use of the term of mobile learning communities.
- Regarding cognitive/emotional states the following were evident Challenging situations such as personalizing and structuring learning and sharing knowledge. Secondly the perceived need for an intervention in terms of support both technical and learning. Lastly a sense of value or usefulness of the PDA measured in terms of its repository valued for managing assignment submission, contact information; ideas and making connections with other people.

Taken together we put forward the following framework which highlights the ways in which students approach mobile learning and the rich complexity and interrelated factors between the individual, the tool and his environment .

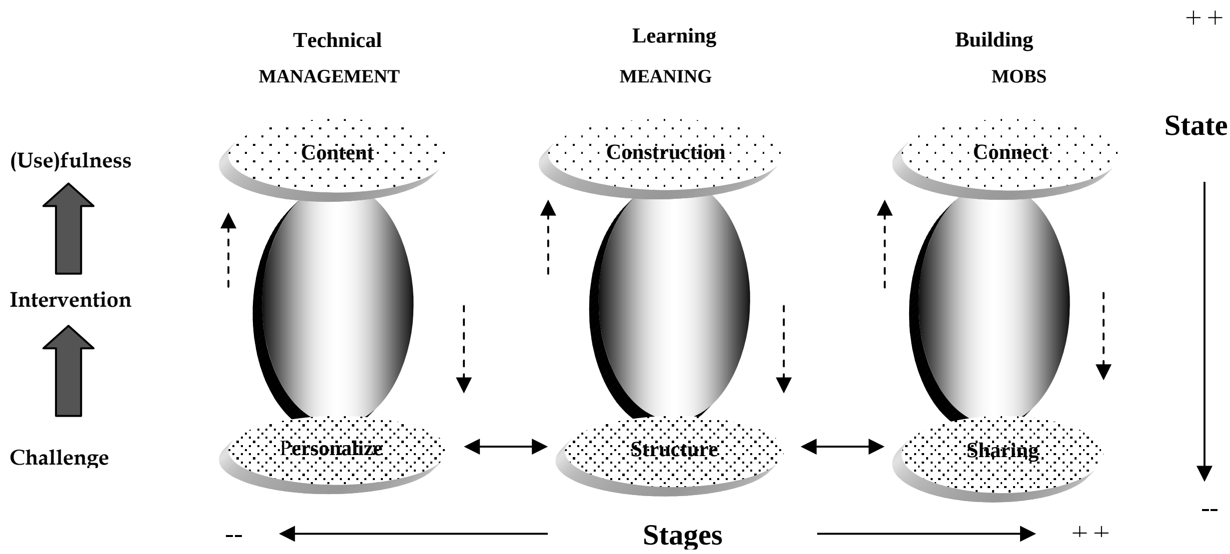

Figure 1 A framework for evaluating the mobile learning experience

Our framework provides a simplified but holistic approach to understanding issues in mobile learning design. One of the major objectives of our study was the need to gain a better understanding of how learning occurring in one context can be mapped unto learning in other. A related objective was the challenges associated with this process. Our contention is that for PDAs to be effective as learning tools the social affordances of the technology must first be addressed. For learners to be motivated to use such devices it has to be integrated into their everyday activities for example scheduling of learning activities, lecture timetables, recording lectures, managing assignment submission, maintaining contact information of friends and tutors, and also entertainment. In this regard our findings share some of the lessons learnt from the student learning organizer project (Holmes, Sharples 2002). This calls for the profiling of learners (Becking et al 2004), and understanding of learning environments and conditions (Walker 2007). Our findings support the viewpoint that there is a mismatch between our current offerings and student potential usage of mobile technologies (Conole et all 2008). Our second contention is that support for mobile learning must be prised apart to attend to technical as well as learning support. Technical support must be both progressive and distributed and designed to reach-down, reach-out and reaching-around specific individual needs, situations and learning context. Underworld support structures must be tapped and where possible nurtured. Learning on the move must go hand in hand with support on the move. In respect of learning support this must take the approach of deep support (Williamson 2006). Other factors which need to be considered are "Attention" and "Framing" of learning objects / goals, (Kress and Pachler 2007), and "reflective dens" (Facer et al. cited by Naismith et al 2004) or "thoughtful territories" Bell (2008) for learners to think back and ponder over their learning experiences and in the process enhance the quality of knowledge construction. The accessibility issues unearthed through this study raise questions about the conundrums of institutional policies and structures. Accessibility should not be grafted unto the learning design but must be an integral part of the process. This should address both physical access to resources held remotely and also accessibility of the learning experience (Rainger 2007 p. 67). It calls for an understanding of the psychological, organizational and social factors of how people operate (Kukulska-Hulme 2007 p. 45-56). Our study has found that knowledge sharing was limited by issues of cost, regulatory policies and existing infrastructure. We contend that for learners to feel empowered to share their experiences in a mobile context, institutional infrastructure, regulatory policies, and learner friendly cost models must be adopted. Examples of useful models are evident from the work of O'Malley et al (2003)

Conclusion

The findings reported in this article are based on the exploration stage of the WoLF project which is ongoing. It is therefore difficult at this stage to assess the full impact of the PDA on the learning experiences of TA's. Notwithstanding we have found evidence which support the view that use of PDAs can either help or hurt the mobile learning process base on personal, institutional and environmental factors. Our framework provides a way of thinking about the help and hurt dimensions of using mobile devices for learning and their implication for learning design. Our findings and suggested solutions may not fit into all contexts however they demonstrate how effective user proposed interventions can be employed. We also need to point out that our solutions are not definitive statements of what must happen in a mobile learning design but rather they illustrate ways of attending to learner concerns. What they are designed to achieve is reflection on practice and inclusive and innovative designed which can be beneficial to the learners experience. From our analysis of the range of activities carried out by Teaching Assistant in various context, we argue for an integrated approach to mobile learning design that takes into consideration, user background, individual needs, affordances of learning spaces, personalized and distributed support and above all institutional polices which enhance pleasure of the learning experience.

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Best Practices for mobilizing Educational Media in Higher Education

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ABSTRACT

How do we assure we are diffusing innovative use of educational media? How do we encourage educational media casting as an educational enhancement at an "institute of technology"? What pedagogical models of educational media casting do students value? If we cast it will it add value to the learning experience?

This paper, based on a study of both distance and on-campus faculty and students at a public Post Secondary institution, will present best practices for effectively implementing media casting as an instructional resource.

The researchers will first outline a definition for media casting, create a distinction between asynchronous and synchronous casting approaches and then expose the issues related to the selection of media for distribution. The researchers will highlight the results of related investigations found in academic literature. Many findings allude to the misconceptions of media casting as an instructional tool and understanding these misconceptions is an important first to effectively deliver media casts in Post Secondary institutions. The researchers will then elaborate on the factors that effect faculty implementation, student value and need, and the resulting best practices we propose as a result of our findings.

Author Keywords

Media, podcasting, best practices, diffusion theory, value, use

INTRODUCTION

This paper will summarize the results of faculty and student surveys conducted at the British Columbia Institute of Technology (BCIT) a Canadian Public Post Secondary Institution. The surveys examined the use of media casting amongst faculty and the value associated to media casting amongst the student body. Faculty's personal beliefs about educational technology where also surveyed. The purpose of this examination was to identify factors that could potentially impede the adoption of educational media casting in an institution that is an "Institute of Technology" by name and definition. Identification of these potential impediments will help to establish a model for BCITs further diffusion of media casting amongst faculty, staff and students. The researchers believe that the diffusion of media casting will rely heavily on the design of services to support the needs of faculty and staff while maintaining media castings perceived value amongst the student body.

BCIT is one of Canada's premier Polytechnic Institutions. One of its mandates is to "conduct technology transfer activities by providing opportunities for innovation, industrial assistance and contracted applied research". One of BCIT's institutional level support mechanisms to fulfill this mandate is the Learning & Teaching Centre (LTC). The LTC is committed to "providing a comprehensive set of services and resources that support the core activities and strategic directions of BCIT". With this in mind the LTC, through the 2007 year, built an infrastructure to support the creation of, and storage and distribution (casting) of, educational media.

When designing this infrastructure the project team was guided by the following assumptions (1) technology, faculty members' lives and work, and faculty development are inextricably bound together, (2) learning by doing is effective learning; (3) the rapidity of technological change and its importance for education will neither diminish nor disappear; (4) it is imperative for us to reflect and then act in increasingly vigorous ways on the possibilities and realities of technological change (see Gillespie 1998).

The model of deployment over the 2007 year has been;

1. Encourage the academic planning of educational media within its course context prior to creation
2. Provide learner-centred self support that maintains freedom to innovate, where intrinsic motivation and skill-sets exist, and provides connections to assisted support when and where required
3. Provide a ubiquitous storage and retrieval process to ease training/learning curve of adopters and students
4. Create mechanisms to gather formative evaluation data that will proactively guide innovation refinements without added processes for evaluators or innovators

The surveys and interviews conducted within this investigation will be married with many other data elements (#4) that will provide BCIT with a thorough picture of whether the model deployments benchmarks remain on track. The results of these sessions and the survey data will be married with the following formative evaluation data;

- A survey of faculty who have proactively sought out support to create and distribute educational media
- 12 months of iTunes U course creation, upload and browse/download statistics
- Website tracking (hits) on pages associated to educational media casting information and support

PURPOSE OF STUDY

> "High education is facing a growing expectation to deliver services, content and media to mobile and personal devices… this trend will increase as students put pressure on campuses to offer meaningful content via mobile devices." (Horizon Report 2007)

Institutions adapt to the "digital generation" through the acquisition of hardware, software and systems. Institutions must evaluate and implement new technologies to fuel enrolment and revenue growth (it seems), but people issues, and change management are of greater importance (see Zastrocky et al 2006).

New instructional technologies offer promise to faculty and students that use them. Mobile devices that can store and play downloaded content offer the potential to learn 'anytime, anywhere'. This is the mantra that distance educators have used to support their pedagogical philosophy. Media casting is an extension of this belief that further reduces the limits of time and place where learning can occur or be reinforced.

BCIT is in its second year as an iTunes U institution and during its first phase built an infrastructure that focused on contextual support to faculty, staff and students. Pilot projects where used to test the system and now that the support system has been revised, based on early adopters and pilot projects, BCIT feels ready to conduct a survey to gauge areas where further reinforcement of the existing infrastructure is required. This investigation will also expose methods that should be incorporated to allow its Faculty and learner community to embrace this method of media distribution.

REVIEW OF SIMILAR INVESTIGATIONS

Literature focused on the implementation of educational technologies suggests that barriers for adoption include financial limitations, conflicting attitudes between pedagogical philosophy and potential of technology, and time. This paper will highlight some of the overarching themes from the literature that where used to frame the surveying and interviews of faculty and students.

Definitions of media casting

A ubiquitous definition of media casting (podcasting) does not exist in the academic literature.. The common theme in most definitions seems to be the obvious characteristics of what podcasts can do. That is, deliver content in the form of audio and/or video files over the internet but this too is the definition of Streamed media. The main discrepancy in most definitions and similar investigations surrounds the issue of time. In the traditional sense, podcasting has been an asynchronous activity where content has been captured, edited, and posted in a specific sequence. There is a time delay that exists between the live presentation of materials, and the distribution of content to the intended audience. This form of media casting is the definition the authors of this paper will use throughout this paper in reference to media casting.

The synchronous version or form of content delivery, sometimes referred to as 'webinars', is different from traditional podcasts. The boundaries of 'any time and any place' are restricted in much the same manner as traditional face-to-face learning. DiMaria-Ghalili, Ostrow and Rodney (2005) defined web casting as the delivery of 'synchronous broadcasting to students in their homes, places of employment, or local libraries using Web-based streaming video and synchronized multimedia presentations' (p. 12).

Many institutions have developed proprietary systems for web casting (Rowe et al., 2001; Harley, Henke & Maher, 2004) leading to further misconceptions and diverse definitions of media casting. The Berkeley Internet Broadcasting System (BIBS) is an elaborate system developed for delivering web casting to students at the University of California at Berkeley. The BIBS system offers both live and on-demand web casts. For systems like the BIBS, media casting can be both synchronous and asynchronous.

Implementation of educational technology

Everett Rogers' diffusion of innovations theory is amongst the most widely used and sited theory found in the academic literature. Rogers (1995) developed four significant theories of diffusion. Three of these theories are applicable to media casting and are supported by research in the academic literature.

Rogers' (1995) Innovative Decision Process theory proposes that diffusion 'evolves' over time and can be identified by five distinct phases: a) knowledge, b) persuasion, c) decision, d) implementation, and e) confirmation (Rogers, 1995). The knowledge phase refers to potential adopters learning about a particular innovation. Persuasion is the phase where the adopter is influenced to implement an innovation based on its merits. Decision refers to the decision to accept and implement a particular innovation. Finally, confirmation is the reaffirmation or rejection of the decision to adopt the innovation. This theory of diffusion is widely cited in instructional technology literature (Sachs, 1993; Surry & Farquhar, 1997).

The diffusion theories listed have been utilized in various disciplines to describe the nature of diffusion of technology. Reluctance to embrace and utilize technology is not unique to education. Donald Ely (1990, 1999) proposed eight conditions for the facilitation of implementation of technological innovations. Ely's theory is widely used in instructional technology. It highlights the conditions for implementation of innovations. Ely's conditions for implementation do not focus on barriers; rather they emphasize characteristics that have been identified in successful implementation of innovation in instruction (1999). Ely's conditions for implementation are stated as: a) dissatisfaction with the status quo, b) existence of knowledge and skills, c) availability of resources, d) availability of time, e) existence of rewards or incentives, f) participation, g) commitment, and h) leadership.

Dissatisfaction with the status quo is the impetus for many research investigations. The most significant investigation has been the Duke Digital Initiative at Duke University. The four main goals of the Duke Digital Initiative were to promote innovative and effective teaching, to use technology to support curriculum enhancements, to expand and develop a technological infrastructure, and to share these experiences with the academic community (DDI, 2006) and are mirrored in the BCIT initiative. These goals clearly suggest that change in the status quo was the incentive for developing such a project as the DDI. Other studies have also implemented technology in response to maintaining a 'business-as-usual' approach to instruction (see DiMaria-Ghalili, et al., 2005; Harley et al., 2004; Traphagan, 2006). In all of these studies pervasive themes have been change. The reasons or purpose that drives change is broad. Change can be the result of an intrinsic need to update stagnant practices, or it could be the result of a more technologically savvy student body that wants learning to be supported by technology. Another consideration for change is competition. Developing distance programs using web casting and internet technologies enables institutions to develop programs that will help expand their reach to potential students who might be tempted to pursue studies elsewhere (DiMaria-Ghalili, et al., 2006; Pajo & Wallace, 2001).

Commitment to implementation is often characterized by the availability of resources (DiMaria-Ghalili, et al., 2006; Spotts, 1999). Many institutions have made considerable expenditures for the development of web-casted materials (DiMaria-Ghalili, et al., 2006; Rowe et al., 2001; Traphagan, 2006). Some institutions have created studios for media production. Others have furnished classrooms across their campus with cameras and recording devices to capture and cast lectures (DiMaria-Ghalili, et al., 2006; Rowe et al., 2001; Traphagan, 2006). A strong sign of institutional leadership and support is making resources available for implementation of innovations but, as stated earlier, acquiring hardware software and system is not enough and supporting innovation is key.

In the present investigation, as with other research findings, time is a critical resource for implementation of technology. Spotts and Bowman (1995) found that fewer than 40% of faculty surveyed at a large U.S. Midwestern university had good to expert knowledge or experience with newer instructional technologies. This emphasizes the main obstacle for implementation of innovation in education, that is, a large percentage of faculty members are unfamiliar with innovations in instruction (Dooley, 1999; Pajo & Wallace, 2001; Rowe et al., 2001). The barrier for implementation is often a result of not providing sufficient professional development or release time for faculty to adequately learn newer instructional technologies (Ebersole & Vornddam, 2003; Pajo & Wallace, 2001).

More recent investigations show that the final three conditions of Ely's theory are essential for the sustainability of a technological innovation (Zellweger Moser, 2007). Zellweger Moser (2007) suggested that institutional support and lack of funding were the primary reasons why innovations failed to become institutionalized. Zellweger Moser (2007) examined the educational technology support strategies of various institutions to attempt to explain the mechanisms that guide faculty behavior regarding educational technology.

The conditions described by Ely (1999), and Rogers (1995) are prevalent in this adoption cycle. The major hub of this cycle is the condition of time. Time commitment for implementation is deceiving. First time commitment can refer to the actual preparation time of content to be delivered via a media cast. Similarly, time commitment can refer to the preparation of equipment to be used to deliver the content. This distinction will be addressed later in this paper.

THE STUDY

Introduction

The value of educational media casting amongst students and the use of educational media casting amongst faculty is being studied as BCIT enters it second phase of implementing media casting as an instructional enhancement. A survey of both student value and faculty use served to gauge current early adopter opinion, laggard motivators to adoption, and students perceived value with respect to the use of casting to support their learning.

The process

Two online surveys where produced. One survey was delivered to faculty and staff while the other was delivered to the student body. Both surveys where open for two weeks and incentives where used to encourage response from both groups (iPod draw). At the survey close date there had been 64 complete responses to the faculty survey and 274 complete responses to the student survey that represented all 6 school segments of BCIT and where representational of all modes of delivery from fully online to fully face to face. More that half of all participants agreed to participate in the next phase of the studies phone interview which is encouraging.

Results of the Faculty survey and interviews

Survey results amongst the faculty members provided a unique perspective on issues related to the implementation of media casting. The survey achieved a 60% completion rate. The highest number of respondents came from the Health Sciences (26%). The survey was also predominantly completed by full-time faculty (over 78%). There were more surveys completed by male faculty members (64%), and the average age of all respondents was 41.

The primary factor that would affect implementation of media casting is interest level. We asked faculty to indicate their interest level in media casting using a three-point Likert scale (1 = low interest, 3 = high interest). Over 53% of the respondents indicated a moderate interest in media casting, followed by 25% who indicated a high level of interest in media casting.

Earlier studies on the implementation of technology suggested that diffusion is a result of knowledge of the technology. We sought to identify a reason for relatively low use. Based on earlier works (Compeau & Higgins, 1995) we attempted to see if there was a relationship between comfort level using technology; computer self-efficacy, and interest in using media casting. We found that there was no significant difference between the low interest group and high interest group in the scores of computer self-efficacy ($F(12,15) = 1.19$, $p < .05$). Similarly, there was no significant difference between the moderate interest group and high interest group ($F(15,33) = 1.69$, $p < .05$). From the interviews conducted of BCIT faculty members, nearly two thirds (66%) were able to provide a technical to non-technical definition of media casting that was deemed accurate or correct. The interview participants were also asked about their level of comfort using educational technology. Almost 60% of respondents stated they are very comfortable and another 25% said that if they where provided support they would be willing to try media casting. The reason for these results could rest in the fact that the participants surveyed all have a significant level of proficiency using technology given the nature of BCIT. That said when interviewees where classified there where near equal numbers of “early adopters” vs. Laggards. Early Adopters are those members who implement and use technology early in its inception. Laggards are those who wait for the implementation of technology to see how it can be used, and to wait for any preliminary problems to be resolved.

Within the academic literature there is a central focus on providing sufficient support services to implement technology. These services are aimed at making technology more accessible and efficient. Although the level of support at BCIT (program, school and Institutional level) are considered “sufficient” by faculty (elaborated on later in this paper) when asked if they proactively sought support from the LTC over 26% of the respondents were neutral. The next largest group (12.5%) were those that do not actively seek support services. Only 9% of those surveyed indicated that they actively sought support assistance from the LTC. Approximately 20% of those who sought support services did so by looking for help online at the LTC website. The LTC provides much of the support required and identified by Faculty that would be required to successfully implement media casting but this investigations results expose the strength in such factors as intrinsic motivation (also noted by faculty as one of the incentives required to successfully implement media casting at BCIT).

The issues mentioned above address the central themes of intrinsic confidence levels with using technology, and extrinsic support structures. Diffusion of innovation, as mentioned earlier, is also dependent on the level of innovativeness or creativity one believes they possess.

How do we assure we are diffusing innovative use of educational media?

Time is the most critical issue for successful implementation. When asked what percentage of time they would be willing to spend, in addition to their current preparation of course materials, to implement media casting the average amount was almost 6% ($M = 5.76\%$, $SD = 7.98$). Time not only refers to the preparation of the content to be used in a media cast, but also the time required to setup equipment before the presentation of material. Assurance for successful implementation must entail a model or method of employing media casting that is reliable and efficient.

Those faculty members that are presently using media casting have done so in a manner that augments their traditional face-to-face, or distributed learning design. That is, they have not considered media casting as a replacement for lectures, rather it is used to add additional materials, complement lectures, or act as a source for review for students. This best practice has proven to be most effective in other studies (Rowe et al., 2001; Traphagan, 2006).

Another consideration for the efficacy of media casting is to provide materials, via a media cast, as a prelude to upcoming lectures or sessions. By using this practice students with a keen interest in the content will come to the class meetings prepared. This will also provide a valuable mechanism to ignite interactive discussions in classes. Only 7% of those surveyed believed that media casting would isolate students from faculty. Almost 33% of the respondents disagreed with the notion that media casting would result in isolation from students.

How do we encourage educational media casting as an educational enhancement at an “institute of technology”?

Ely (1990) proposed three conditions (of the eight) for successful implementation of instructional technology; i) participation, (ii) commitment, and (iii) leadership. Most of the respondents agreed that media casting was a valuable resource (47%), and a considerable amount strongly agreed with this sentiment (23%). These results suggest that faculty appreciate the potential of media casting.

The largest perceived benefit attributed to media casting by faculty members was the enhancement of course content. Enhancement is defined as video demonstrations; graphic identification of content, and study aids. The second largest perceived benefit was the augmentation of lectures through the use of media casting. In this study augmentation refers to lecture notes, prelude to or review of lecture content, annotation resources of similar works. This suggests that faculty members are not viewing this technology as a means to replace lectures. In fact, the perceptions of faculty members are in line with the student requested use of podcasting. That is, the addition of material to enrich learning without effecting course quality and instructor contact. The third largest perceived benefit was rather intuitive. The use of media casts by Second Language learners. Faculty projected that repetition of content could help to overcome language barriers.

Incentives to implement educational media casting were wide and diverse. Faculty members seem realistic in their desire for incentives. The largest desired incentive is release time to create and develop content or media casts for courses. Support from departments like the LTC were also desired incentives for implementation. At the same level, faculty wanted extrinsic incentives like recognition or rewards for effective implementation of media casting. Financial incentives, and recognition for tenure were the least desired incentives. This might be due to the fact that these are likely unrealistic incentives that could be offered.

The above results are marred by the fact that on average faculty said they were willing to invest about 6% more effort in their instructional practice (M = 5.76%, SD = 7.98). Faculty are willing to make marginal time commitments for implementation regardless of the above-mentioned incentives.

We wanted to examine the perceived level of support from various levels within this institution as a measure of leadership. Respondents used a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) to indicate the level of support within their department (M = 3.23, SD = 1.70), school (M = 2.92, SD = 1.216), and institution (M = 3.06, SD = 1.286). The summary statistics do not clearly indicate where the greatest level of support resides. An ANOVA of these three groups was performed to see if there was a significant difference in the perceived level of support. The results ($F(2, 188) = 1.11$, $p < .05$) suggest that these levels are not statistically different. Therefore, the perceived level of support is similar amongst the department, school, and institution.

During interviews the perceived level of support provided by the LTC was positive (70% good, 20% bad, 10% never used). Perceived support is dependent upon individual expectations of the perceived role of the LTC. Some faculty may have higher expectations of this department and when expectations are not met, because they do not fit the true role of the LTC, than the level of support might be deemed bad, or insufficient. The 'bad' reviews here were based on the availability of people and time it took to see someone who could help. It had nothing to do with the type of support provided or the quality of support. These 'bad' reviews could be alleviated with more faculty contact time and quicker (shorter timelines) for responding to requests.

When faculty members were asked what prevented them from implementing educational media casting they indicated the following issues/barriers that have prevented them from using this technology (in order of severity):

1. Technological comfort
2. Time for development, and set-up of technology
3. Awareness of tools and support services
4. Personal interest / support
5. Cost

Support (within #4) refers to the situation where technology might fail. This is more of a technical support issue, or classroom support (Ed. Tech). The awareness of tools refers to the faculty member becoming aware of what tools are available to implement this technology and the support available for piloting this distribution method.

The encouragement to use this educational resource must come from other sources. Faculty perceive this as a valuable tool. Faculty perceive that they are getting support from all levels within BCIT. Release time is available to faculty when they decide to implement technologies. Perhaps implementation could be more widespread if the perceived value is demonstrated by faculty members who are effectively implementing this technology.

Results of the Student survey and interviews

Surveying students provided an opportunity to validate the "value added" impression that exists about media castings as an enhancement to the learning experience. 274 students responded to a 20 question survey to determine opportunities that exist to claim "dead time" as a learning opportunity, and students perceived value of and their expectation of, BCIT to utilize casting as an academic enhancement. The highest number of respondents came from the School of business (38.5%) with near equal response from trades and apprenticeship (24.5%) and the school of Computing and Academic study (22.7%) and the school of Health Sciences students make up the remaining amount of respondents. The survey was also very strongly balanced between full-time student respondents (45.6 %) and part time student respondents (50.2%), which is well above BCIT norm of 10% full time student respondents. There was also a strong balance of male to female respondents with 54.4% of responses coming from male students and 45.6% coming from female students. Exactly half of all respondent where 25 and under.

If we cast it, will it add value to the learning experience?

BCIT is an "Institute of Technology" but encourages and supports, through its Learning and Teaching centre, the use of educational technology as a tool to enhance teaching *in context* to the learning experience. We encourage the *academic* design and development of technological enhancements and the inclusion of technological solutions within this context. Technology for technology sake is fiscally irresponsible and has proven to be counterproductive to our applied education mandate. It is critical as BCIT moves toward widespread communications about media castings adoption that we gage the perceived value of this service amongst our student body.

To determine "added value" the researchers needed to see if opportunity exists to first access and then utilize media casts. The survey looked at whether students owned mobile devices that could be used to access media casts and what each student's current workload was. The researchers also attempted to gauge the "dead time" that students had in their weekly schedule.

Results showed that 54.7% of respondents had a portable audio player, 20.8% had a mobile media device that allowed them to play a video file and more than half also had a cell phone that could be used as an audio/video player (having at least 2GB of storage). Not surprisingly to the researchers 43.4% of respondents had multiple mobile devices that could storage and play media. We looked to transit time to check on the most obvious dead time that might be utilized for playing media being cast and 54.4% of respondents took transit or walked to school and 41.2% of respondents had more than a half hour to more than an hour of travel time each way. When asked during interviews where student's access and use media only 26.6% accessed and used media during their commute. This might be due to a disconnect for students in seeing mobile phones, ipods and other media players as a tool to house educational content. This is likely connected to the finding of current podcast subscribers and how they are accessing and viewing media (below).

Although 82.8% of all respondents said that they knew what a media cast (podcast) was in the survey interview results show this number to be just over 65% (still an encouraging number). Just over 70% of students do not subscribe to podcasts for any reason (including personal hobbies and interests) according the survey but the interview exposed the fact that approximately 50% frequent iTunes, YouTube and photofeeds, all of which serve only one need; to distribute media. Of the remaining almost 30% who do subscribe to podcasts 12.6% watch between 10-20% of them and only 9.2% watch between 80-100% of podcasts they subscribe to. That being said when asked if they would watch a podcast that the instructor provided to them 85.4% of respondents said that they would. Interesting to note is that of those that watch podcasts currently, 77.3% of respondents watch them on their computer/laptop and only 20.7% watch from a mobile device. Students do not even come close to utilizing the original intent of casting media (distribution through subscription for playback on mobile devices). This was supported through interview conversation and the 60% of respondents owned both a laptop and desktop computer; they seem to consider their laptop as a mobile device. Most students know what casting is but most do not subscribe and of those that do most do not even watch them. For those that do watch them they don't even view the file from any one of their mobile media devices and seem to treat the media being cast much the same as any media distributed through any other means (i.e. streamed, emailed).

What pedagogical models of educational media casting do students value?

When students where asked the value (from extremely valuable to no value) they associated to specific types of media casts students perceived lecture review/summary, exam study aids and video demonstrations as more valuable than others identified in figure 1. Survey responses and comments also clearly indicated that they did not perceive student created media as part of project work of much value and felt that student created media casts transferred the burden of teaching from instructor to students.

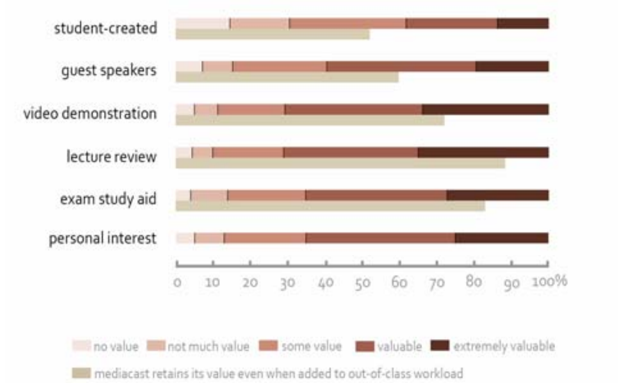

Figure 1. Value and Value retention of varies types of media casts, as determined by students

Students were also asked questions about their current workload and if they were willing to increase this workload slightly to have access to media casts. When asked how much time, on average, they spent on coursework (outside of class) per week responses ranged from 1 to more than 40 hours with the average amount of hours per week for all respondents being 14.3 hours per week.

When students where asked, based on the value they associated to each type of media casting, if having access to these items added a small amount of time to their workload outside of class would they still value them respondents indicated that lecture review/summary and video demonstrations would retain their value and students indicated that media casts as an exam study aid increased their perceived value as identified in figure 1.

Of those student who did not see podcasting as having academic value 17.5% of respondent simply did not know what a podcast was so did not associate any value to this media distribution method. Some respondents commented on its usefulness but had concern about their instructors taking on too much technologically "I still have instructors who still do not know how to use the computer tablet for instructional purposes so I think that adding this would be too much technology for them." The most common theme to responses, to the "no value" question, was that students felt that "It is just another way to transfer direct teaching into technology takes away from actual instructor-student relationships. Why pay tuition when I have to teach ourselves?" and "if a lecturer cannot present the required material in the class and needs to use a supplemental form to present the material to the class that means that the course requirements are too high, there is too much material to cover". When interviewed student identified a number of course that should be enhanced with media and an overwhelming number of the identified courses where because of heavy content with not near enough time to cover it in class. These sentiments are mirrored by 21% of the 57 respondents who had concern about it replacing contact time and wanted it to be used as supplemental material only and not worth marks or replace time with instructors. Other respondents commented on the fact that guest lecturers already give them their PowerPoint's and instructors already give them their lecture notes which they find very useful as supplemental resources and that "podcasts are unlike lecture notes or texts in that they can't be skimmed or outlined – an hour of podcast will take an hour of time". Lecture notes are another media that could be distributed via casting in PDF form and should be considered within the scope of media casting.

RECOMMENDATIONS FOR MOBALIZING EDUCATIONAL MEDIA

Institutions need to concern themselves less on computer self-efficacy and more on providing release time for instructors to create media for distribution through methods such as casting. Institutions need to provide incentives for those successfully implementing this type of educational enhancement. Showcase examples and effective use of these enhancements to increase faculty motivation. Faculty have voiced the value they associate to exemplars so promote your early adopters.

Perception is reality until it has been invalidated. The academic community seems to have the misguided perception that media casting is a means of capturing lecture and that it replaces instructor/student contact time with the potential for student to "skip out" of course participation. This investigation has identified, through Faculty and student input, enhancements and augmentations that would serve the needs of faculty and students without effecting course outcomes or contact time. Consider the creation of media casts that supplement lecture through previews of the lectures content; create a sound bite as a prelude to your lecture. An option that students consider of great value is an video/audio file that summarizes/reviews major points from lectures, readings, or each week of the course.

Students have overwhelmingly identified "heavy content" courses (law, stats, anything that requires spatial reasoning, health/clinical techniques courses) as *requiring* support through audio and video that will reinforce and demonstrate difficult to visualize concepts. Students speak of these courses as frustrating. The information needing to be covered is too large for the amount of time they have in class and yet the standard practice has been in class review of content already covered. Providing learners with out of class media (audio/video/PDF) to complete these reviews will allow for in class discussion time and "contact" time for relationship building.

Limiting the time that is spent creating and administering media casting will add to its appeal. Fewer pieces of media that are short/succinct that focus on enhancing the learners experience and that allow the opportunity to strengthen the instructor student relationship are of value to students so consider casting as a distribution method.

If student created media are being considered, look to them to enhance existing student interaction. If the course is being delivered whole or partly on line and student interaction is limited as a result student created media, in this context, should be considered for casting.

Students have not fully realized the benefit that casting media can bring to the learning experience and are accessing and viewing the media casts much the same way that they have accessed and viewed traditionally delivered media. Institutions and Faculty need to work together to highlight the benefits of media casting as it is being introduced at the program and course level. This will add a small amount of administration to incorporate these enhancements but will pay off in the long run. Do not assume that learners already know all that is required to make best use of this media distribution method. Make sure to introduce students to media castings ability to reduce the time and skill required to retrieve media resources and its provision for mobility of educational content.

Not everything can be cast in a useful way. Some things evolve at a rapid rate and by the time some media is created and cast it is already out of date. Some programs like multimedia rely heavily on code review and audio and video do not lend themselves to this text based resource. It will be important to pick and choose what content adds value as a media cast. Faculty need to proactively seek support from technology and academic professionals who will encourage this key factor in successfully incorporating casting into their instructional practice.

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The Role of Mobile Technologies in Moving 'Digital Natives' to 'Learning Natives'

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ABSTRACT

Evidence indicates that mobile technologies have been used most widely in school-based projects to date to support a specific range of learning processes. Some evidence suggests that a major outcome has been the development of 'digital natives' rather than 'learning natives'. Some important current projects focus much more on learning in context ('real' or authentic learning possibilities), using aspects of communication, focusing on forms of social interaction, and developing engagement and support through societal settings. This paper uses a gap analysis across learning domains to identify those learning elements that are supported currently by mobile technologies and those where wider uses of affordances would be likely to support effective learning. The research literature suggests that important benefits are likely to arise if a greater focus on learning activities is placed on activities where communication, social and societal interactions are involved. A range of activities already developed, and aspects that could be developed to support significant long-term learning potential, are highlighted in this paper. It is argued that the focus on these elements will be fundamental to the development of 'learning natives'.

Author Keywords

Mobile learning; social, individual and cultural learning contexts; learning frameworks; the future of mobile learning

INTRODUCTION AND BACKGROUND

It is well recognised that many young people might be regarded as 'digital natives' (suggested by levels of access to technologies reported in Becta, 2007, for example). However, being a 'digital native' does not necessarily mean that a young person is also a 'learning native'. Although needs of 'learning natives' can be supported by technological environments that now exist, whether social and societal values, interests and structures accept and support these aspects, is an important question if the concept of 'learning natives' is to be developed. Whilst this paper suggests that 'mobile learning' is likely to have a key role to play in this development, and that some important identifiable elements are now being evidenced in practice when developments focus on aspects of learning beyond just immediate cognitive needs, the paper also considers learning within a wide context, exploring a range of school-based practices offering 'mobile learning' for all, analysing these through appropriate learning frameworks. The paper is concerned with exploring the relationships of known outcomes to a wider picture of educational and learning necessity, to identify what this can tell us about a future for 'mobile learning'; the focus is placed on 'the bridge from text to context'.

This paper is fundamentally concerned with learning; it considers what contribution 'mobile learning' makes to a wider learning need, and implications for the current and the future. Definitions of 'mobile learning' vary across communities. Wikipedia (2007) offers ideas about the definition by referring to its relationship to e-learning and distance education, highlighting three distinctly different elements: learning with portable technologies, where the focus is on the technology (and this could be in a fixed location, such as a classroom); learning across contexts, where the focus is on the mobility of the learner interacting with portable or fixed technology; and learning in a mobile society, with a focus on how society and its institutions can accommodate and support the learning of an increasingly mobile population. This paper will focus on the second of these aspects, but will also consider roles of the other two aspects from the perspective of the former. This categorisation allows learning to be considered from an individualistic perspective and from a group perspective (where a small working group operates as an entity, co-operatively and collaboratively undertaking problem solving, effectively having authorship of responses that are then reported to a teacher).

Early ideas about the potential for mobile technologies to support learning (Sharples, 2001), were shared with issues for both teacher practitioners and for learners, for while it was pointed out that learners could use an increasing range of mobile technologies to support learning anytime anywhere, it was also pointed out that these technologies could disrupt a classroom managed in more formal or traditional ways. These ideas indicated strongly that there was (and this paper suggests that there still is) a need to understand much more about roles of mobile technologies, how they might support specific aspects of learning, how learners know where the challenge of what is to be learned comes from, and how the realisation that something has been learned becomes transparent to an individual or group, with seamless links to positive assessment for the individual (see models of assessment proposed by Ridgway, McCusker and Pead, 2004).

This set of issues, particularly the need to understand roles and relationships (both from learner and teacher perspectives), has neither diminished nor been superseded. Naismith, Lonsdale, Vavoula and Sharples (2004) stated that mobile technologies were becoming “more embedded, ubiquitous and networked”, and that “learning will move more and more outside the classroom and into the learner’s environments”, while Ley (2007) suggests a firm focus on relationships and roles of formal, informal, and societal aspects of learning are likely to be fundamentally important for many years to come, since “ubiquitous computing, with an extensive real world web of networked objects and devices may take at least 10-15 years to come close to being realised”. Roschelle (2003) noted that certain technological features would almost certainly be important in terms of implementation and practice supporting learning, while an over-simplistic view of roles and appropriate developments of social practices could well diminish outcomes.

Reports from a range of pilots and projects suggest that mobile technologies can support social engagement with, and outcomes from, learning. Uses with ‘hard to reach’ learners, in a project involving nearly 250 young people (aged 16 to 24 years) in the United Kingdom, Italy and Sweden conducted by the LSDA (2005), reported that ‘smartphones’ might provide ways to motivate young adults not in employment, education or training. Across the study sample, about four out of five young people reported that they felt mobile games could help to improve reading, spelling or mathematics. A more recent study for Becta (Passey, Williams and Rogers, 2008) suggested that young people do have wide access to mobile (and less mobile) technologies, but that the technologies used mainly for learning are computers with internet access and televisions, both much more fixed than mobile. Mobility features were reported by these young people to be used for social purposes, while the links to learning were not strongly made by many of these young people.

Some studies have identified impacts of mobile technologies on learning. Lai et al. (2007), looking at learning outcomes in two fifth-grade classes in an elementary school, found improvements in knowledge creation during experiential learning. McFarlane, Roche and Triggs (2007) were more cautious in reporting findings from a study looking at learning outcomes when pupils used mobile technologies. They reported on the development of independent learning approaches emerging. Reports suggest that learning outcome (rather than potential) has yet to be evidenced widely.

In this context it is perhaps not surprising that a current research agenda, suggested by Alpine RDV (2007), should “Focus on scenarios that attempt to create learning opportunities which would not be possible without mobile technology”. In taking such an agenda forward, from a research design and methodologies perspective, the Institute of Education (2007) highlight elements worthy of consideration: mobility is concerned with the lifestyle of the learner; learning often takes place in short gaps between transitions; “mobile and informal learning research methods need to allow us to study not only the learning that occurs during the learning experience, but also how it develops afterwards”; “Learning does not result from single, individual experiences, but rather it is cumulative”.

We appear to know more currently about mobility of technology than mobility of learners or learning; although features of technological mobility are often identified and discussed in the literature, this is not true of mobility of learners or learning. Fundamentally, a key element for a wider understanding is likely to be an identification of relationships between formal and informal learning, whether indeed some learners might lean towards one rather than the other, and how learners and teachers manage this situation effectively. Existing evidence indicates that contexts and social circumstances can determine a lean, while concerns with subject cognition, creativity, and physical interactions may well be important factors in the management of the integration of both elements. It is clear that we are likely to benefit more from knowing about details of learning outcomes, rather than having access only to generalities.

THE THEORETICAL BASIS OF THE WORK PRESENTED

One approach to gain more detail about learning outcomes arising when mobile technologies are used, is to take a detailed framework of learning aspects, against which outcomes can be plotted, to identify strengths, weaknesses, and potential affordances (see Passey, 2006a; 2006b). The background to the detailed framework used is outlined here.

Since any activity or interaction of an educational nature is unlikely to impact a single learning process or domain, a wide range of different learning aspects needs to be identified and selected. A review of current research literature on learning outcomes identifies a number of key domains, as well as focal elements within each of those domains. Six key domains offer a first level structure for the creation of a learning framework, and these are:

- Megacognitive (a term used here to describe those elements becoming recognised as fundamental to developing ‘expert learners’, deep learning, and wider learning, concerned with learning that goes beyond the ability to learn, that enables learners to transfer their learning both within and across subject or interest domains). The literature discusses the importance to expert learners of the gaining and using of ‘big pictures’, of working within a Zone of Proximal Development, and the practices of transferring learning from one situation to another. Such elements are described in the work of Bransford et al. (2000), and Vygotsky (1978).
- Cognitive (aspects concerned with the impact of information or external stimuli on the internal mind, the forms of sensory stimuli used to engage learners, the ways in which information is handled within an existing internal information context, and the ways in which a learner can demonstrate or use the learning that has been acquired). The literature discusses the importance of learning processes such as conceptualisation, creativity and thinking skills, as well as the role of memory and the creation of learning outputs within the wider picture of learning. Cognitive elements are described in the work of Bloom (1956), Child (1973), Gardner (1991), and the DfES (2006).

- Metacognitive (aspects concerned with the ways that learners learn to learn, and elements within a learning environment to allow learning strategies to be identified, adopted, or chosen, or for information or knowledge to be transferred from one scenario or situation to another). Elements are described in the work of Presseisen (2001).
- Motivational (aspects concerned with ways in which information is perceived, and the feedback a learner gains in order to recognise learning as worthwhile, or leading in directions of personal or appropriate choice). The literature discusses the importance of success, how to reach learning goals (perhaps breaking activities into a series of steps), and relationships of intrinsic and extrinsic motivation. Elements are described in Passey and Rogers (2004).
- Social (aspects concerned with ways in which a learner interacts with others, within classroom environments or in home or other external environments, and the forms of interaction that allow a learner to access or use information, as well as to share it, or to work co-operatively with others). The literature discusses the importance to learning of forms of discussion (both internal and external), as well as the roles of others within those discussions. Elements are described in the work of Pask (1975), Vygotsky (1978), Lave and Wenger (1991), and Twining et al. (1999).
- Societal (aspects concerned with the ways in which purposes of learning are perceived, the reason that certain information might be selected and recognised as being more fundamentally interesting or useful than other information, perhaps because it can be used within a particular societal, cultural or wider environmental context). The literature discusses the importance of purpose, not just at an individual level, but also at a societal level, and the roles that those external to the learner (at a family, community or societal level) can take in this respect. Elements are described in the work of Lipman (1995), McFarlane (1997), and Moseley et al. (2005).

From this first level structure, a second level is created that details more specific learning aspects in each domain. The total structure (with constituent individual learning aspects) was used to generate an analysis detailed in a later section.

METHODOLOGIES USED TO GATHER PERTINENT EVIDENCE

To consider strengths, weaknesses and potential learning affordances of mobile technologies, findings from a range of studies reporting learning uses and outcomes are considered through the learning framework outlined above. Findings from four selected individual studies are reported here, and these are supplemented with findings from other study reports for the analysis. Evaluation evidence, covering the range of learning aspects listed under the domains in the section above, was gathered in each of the four studies reported in the next section of this paper, largely from interview data, collected from managers and head teachers in local authorities and schools, from school information and communication technology (ICT) co-ordinators, teachers, pupils and parents, but also through lesson observations. The evidence was supplemented both by test data provided by schools, from national Standard Assessment Test (SAT) results in all core subjects, and through supportive evidence provided by project consultants and within internal reports. This primary evidence base is supplemented by documentary evidence from case studies and study reports (Rockman et al., 1997; Passey et al., 2000; Perry, 2003; McFarlane, Roche and Triggs, 2007; Steljes, 2008).

RESULTS FROM PERTINENT STUDIES

The results reported from studies in this section arose from different school-based projects. The projects used different technologies (although focal concerns on raising pupil attainment were similar), and the pedagogical and curriculum management approaches taken were different. The wider ICT context in schools was different, and these contexts are described to illustrate how mobile technologies were used in conjunction with other technologies (or not) in each case.

A PROJECT FOCUSED ON RAISING ATTAINMENT IN LITERACY

The first project used Psion handheld computers, and focused on raising pupil attainment in literacy. Links with other forms of technology in the school were not evidenced, and network access between school and home was not possible. The primary school had a 2-form entry, with 14 classes. Pupils came from a variety of ethnic backgrounds, many being Afro-Caribbean. ICT had been developed for 5 years prior to the project. Key personnel involved were an assistant head teacher (also the head of ICT), and an ICT instructor (who supported teachers using the ICT suite with their classes). The ICT suite contained 15 machines (located in a corridor), all networked, and the school was cabled throughout. The school had access to the Internet via an ADSL line, which was used widely for research purposes, and the ICT instructor was setting up a school website at home (she had broadband access at home). The school had a great deal of software, but not all of it had been loaded onto the network, or explored for curriculum use. Pupils were timetabled to use the ICT suite once a fortnight, with the ICT instructor taking a half class at a time. It was recognised that the ICT suite offered limited pupil access, and only provided for the ICT skill needs of pupils. Pupils had their own logons, and their own workspaces. Many teachers had a laptop, there was a PC in each classroom, and four interactive whiteboards (one in the ICT suite, one in a Year R room, one in a Year 3 room, and one in a Year 6 room). Two computer clubs were run each week after school, covering what might be regarded as more 'fun' things. Booster clubs, run the previous year, also involved the use of ICT. The school had experienced a limited amount of parental interest in ICT.

The school mobile project used Psion handheld computers with all pupils in Years 5 and 6, focusing on enhancing literacy outcomes through enhanced motivation. The project was reported to work well, and the Psion machines were found to have a positive motivational impact upon pupils. Pupils were found to do spell checks, to use the facilities as a thesaurus, and that quantity and quality of writing was improved. End of Key Stage 2 results showed that literacy levels were retained at a similar level over the 5-year period prior to the end of the project, while mathematics and science results went down. Managers in the school felt that the Psions had had impact maintaining literacy levels.

A PROJECT FOCUSED ON RAISING ATTAINMENT IN LITERACY WITH PARENTAL INVOLVEMENT

The second study explored one element of a wider community ICT project. The initiative provided individual PDAs for three classes of Year 6 pupils (involving some 70 pupils) in two primary schools in an area with high socio-economic deprivation. PDAs were equipped with a wide range of utilities and software, selected to support a range of subject uses, with a particular focus on literacy. Those pupils who previously attended the schools in Year 5 had had prior experience of using PDAs. The teachers and teaching assistants involved with Year 6 classes in the initiative had no prior experience of PDA use. Initial training was provided for them, and a project consultant provided ongoing support for both schools. School ICT co-ordinators provided additional in-school support. The initiative, welcomed by pupils, teachers and parents, was reported by all at the end of the project to have supported a number of aspects of learning.

Pupil uses at early stages were largely focused on the operation of PDAs. A greater focus on uses for learning became established within a six-month period. Of 60 pupils interviewed across both schools after six months of use, all but one were engaging positively with the PDAs. Teachers (after 2 months of use) reported impacts on spelling. One teacher commented on the value for pupils of being able to record spellings of words using their own voice, and then to revise them frequently; listening to how to spell, as well as reading the spellings, was felt to enhance learning outcomes in this context. At a later stage, 54 out of 58 pupils indicated features of PDA uses that helped them with spelling. Spelling results retained in both schools suggested that pupils were improving in terms of spelling. However, it was not possible to make a comparison of these results with those of other independent groups to check whether this improvement might have been expected without the use of PDAs. The results did support what teachers reported, however.

After some six months, the use of e-books became widely established. One teacher felt that e-books helped some pupils, due to limited text being shown on the screen, as books with 120 pages were daunting for some pupils. At that time, 48 out of 60 pupils were able to indicate features of PDAs that they said helped them with reading. At an early stage, teachers noted limited impacts on writing, although at a later stage, 52 out of 60 pupils were able to indicate features of PDAs that they said helped them with writing (some of these were at a word rather than a structural level). There was some evidence after six months that pupil expectations with regard to learning were being raised. At that time, pupils were asked whether they felt the work they did with the PDAs was better than other work. All pupils said that the PDAs helped them to do better work, and only 2 pupils were not able to give details about how the PDA was helping them in this respect. In the case of 50 pupils, they were able to indicate features that they said helped them do more work.

After only 2 months of use, teachers felt aspects of communication had been enhanced in a range of ways. One teacher commented on self-esteem and self-confidence being supported, and how pupils shared operational understanding and practices. The teacher noticed that sharing was sustained throughout the initiative, and that pupils communicated with each other, outside immediate friendship groups, when talking about PDA features. Other teachers, later in the project, voiced concerns about some uses of PDAs, and felt that communication between teacher and pupils was being limited.

Many pupils reported that parents became more involved in their schoolwork after taking PDAs home. Of 60 pupils interviewed after six months of use, 57 said that parents or family were more involved; of these, 42 gave details of how they were more involved. The most common ways were helping with tests, times tables, reading, or schoolwork generally (in 17 cases), and regular checking of work (in 16 cases). Interviews with 8 parents from across both schools indicated, after six months, that parents were generally positive about the focus and nature of the initiative. One parent felt that this medium had helped his child (who had autistic tendencies), in expressing emotions and feelings, being able to write rather than having to say things. Many parents and family members had used the PDAs, often supporting activities involving literacy. However, the PDAs remained personal tools rather than tools shared across the family.

Exploring patterns of SATs results for the two schools, percentage attainments at level 4 and above were higher prior to the project than afterwards in all core subjects. In one school, lower levels were consistent across all core subjects, but in the other school the lower level was less in English than in mathematics or science. In this latter school the use of the PDAs to support literacy was more embedded and consistent, and it was possible that involvement of PDAs had contributed. However, this conjecture was not further substantiated; results were not explored in subsequent years.

A PROJECT FOCUSED ON ENHANCING LEARNING THROUGH ACCESS OUTSIDE AND INSIDE SCHOOL

The third study looked at the development of a range of multimedia resources for access on PDAs. The project ran for 2½ years; in phase 1 there were more than 100 devices and 3 schools involved, while in phase 2 there were 1,000 devices and 14 primary and 4 secondary schools involved. Three resources were developed for pupil access (Espresso, Kartouche, and Grid Club), and e-books were introduced (pupils advised on their development). The Espresso resources developed were called Learning Paths (20 or so multimedia resources for SATs work, and 40 learning paths for post-SATs work). It was found that pupils immediately liked using gaming modules, and gaming aspects: Kartouche; e-books; voice recording; and multimedia. Resource development allowed out of school use of Kartouche. Espresso Newsbites, accessed by some pupils, allowed them to see current news items. Like the multimedia aspects, they reported enjoying the use of up-to-date media. Some pupils became involved in personalised learning to the point that they supported personalised learning of others. For example, some pupils produced images with text and audio, and sent these to a Chinese girl (a non-English speaker), to help her learn English.

Some mothers reported a range of benefits: more confidence being developed in their children; greater awareness of what was happening; and monitoring happening on a day to day basis. They reported their children were more creative, more enthusiastic, and their literacy had moved on more. Sharing was recognised as an outcome, with pupils talking about their learning. It was found that applications were encouraging discussion about learning more than content was encouraging this. Pupils felt they could learn '24/7', and the facilities offered resilience for pupils ('stickability').

It was reported by some teachers that the project had opened up new dimensions. A teacher of hockey allowed pupils (in Year 5) to take video, images and audio of how a match went, what players felt, and to store results. This allowed all pupils to be engaged – even those not able to play. Facilities allowed a video of a science lesson to be taken (in Year 7) and for the experiment and results to be recorded in MS Word or MS Excel. Pupils could access KS3 Bitesize material to revise, or create a revision tool, such as an animation of a life cycle of pollination (presented as a flip chart).

A CASE STUDY REPORTING LEARNING ENHANCEMENTS FROM LINKS OUTSIDE AND INSIDE CLASSROOMS

The fourth study is a case study reported from the Steljes Anytime initiative. In this instance, learning between outside environments and internal school environments is linked. The Anytime initiative offers an end-to-end solution rather than a device that needs to be technologically linked and developed with other communication systems. The initiative provided schools with a device (mobile telephone, UMPC or USB Modem), airtime (competitively priced below that offered by commercial providers and with unlimited data usage), and secure mobile broadband access (with little danger of accessing unsuitable sites focusing on pornography, drugs or terrorism). One school involved had previously used ICT to support learning for some 20 years prior to its taking part in a project exploring the use of SmartPhones with a Year 3 class. After a few months of use, pupils used the devices to record video, images and sound when researching soldiers' graves at a local cemetery (as part of a World War I project). Other research approaches involved contact with the Newfoundland Regiment and the Canadian Embassy. Pupils were able to record retails from a soldier's grave using the SmartPhone, and to take these back to the classroom to share with peers via the interactive whiteboard using collaboration software. It was recognised that pupils used the technologies readily, that they worked across a range of features, using the keypad, touch screen and stylus, as well as accessing details as and when required from the Internet. As the head teacher said: "we are seeing differences in the way the children learn both as individuals and as a group … their enthusiasm to learn both inside and outside the classroom".

EVALUATION THROUGH A LEARNING FRAMEWORK ANALYSIS

The results from the four studies offered above, together with evidence reported in other related studies, indicate a range of learning elements that are currently being supported by mobile technologies, as well as those that are more weakly supported, or not supported. By exploring each aspect of learning within the framework, this provides an idea of which elements are being focused on by the selected mobile technology projects, and which are not. The analysis indicates:

- *Affordances supported* are the transfer of learning, attention, using visual, kinaesthetic, emotional, social and interpersonal sensory routes, reception of ideas, searching, generating or developing ideas, gaining ICT skills and understanding, retention, rehearsal, recall, writing, reporting, completing activities, detecting and correcting errors, focusing attention on what is needed, motivation in terms of learning and performance approach goals, teacher instruction, learner explanation and illustration, discussion, questioning, initiating and guiding exploration, teacher direction, appreciative and active caring thinking, recreational uses, and links to home support or informal learning.
- *Affordances more weakly supported* are working in a Zone of Proximal Development, using textual and musical sensory routes, hypothesising, imagining, gaining subject skills and understanding, knowledge acquisition and comprehension, creativity, reconstruction of ideas, enquiry, questioning, speaking, presenting, moving items as part of an activity, monitoring task performance, relating what is known to material to be learned, academic efficacy, identified regulation, performance avoidance goals, learner instruction, direction, demonstration, use of technologies to share ideas and findings, normative and empathetic caring thinking, longer-term educational uses, citizenship, and real or authentic learning.
- *Affordances not supported or only in limited ways* are knowing about the big picture, knowledge application, analysis, synthesis, evaluation, conceptualising, comparing, reasoning, interpreting, drawing, selecting and understanding appropriate strategies, keeping place and sequence, pacing of work, testing the correctness of a strategy, intrinsic motivation, external regulation, teacher discussion, questioning, scaffolding, speculation, consolidation, summarising, evaluating pupils' responses, effective caring thinking, and links to work.

At a megacognitive level, there are examples described where the transfer of learning is happening. Use of video, audio and imagery, as well as access through mobile Internet and discussion with parents and access at home, all suggest that transfer of learning may well be occurring. Some activities are being tailored to individual learners more (for example, literacy or spelling activities), and this appears to be enabling learners to work more within a Zone of Proximal Development. However, there is no evidence that learners are gaining ideas of 'big pictures' about subjects or topics.

At a cognitive level, mobile technologies are clearly supporting attention with regard to certain subject or topic areas. Visual, auditory, kinaesthetic, emotional, social and interpersonal forms of sensory route are being exploited, although the textual and musical routes appear less often to be involved. The range of routes being exploited already appears to support the reception of ideas for many pupils, but others might well be supported through a widening of routes that would then include textual and musical forms more (as evidenced by use of e-books, for example). Within subjects or topics, processes such as searching, generating or developing ideas, and gaining skills (often technological) and understanding are evidenced, although hypothesising and imagining are evidenced less. It appears that the use of mobile technologies to support ideas that might be regarded as transitory or speculative have been developed by teachers to a lesser extent than have ideas that might be regarded as more permanent or factual. There appears to be more use of mobile technologies to support knowledge acquisition and comprehension than there is to support application, analysis, synthesis or evaluation. Similarly, creativity, enquiry and questioning appear to be involved more often than are conceptualising, comparing, reasoning or interpreting. Importantly, however, mobile technologies are being used to support retention, rehearsal and recall in a number of subject areas, with positive results being reported by a range of teachers in a range of projects. However, retention, rehearsal and recall have tended to focus on certain subject uses (such as spelling or revision activities). There is clearly a potential need to balance uses of mobile technologies in terms of subject activities; it appears that the use of mobile technologies for creative and speculative activities has been developed in limited ways at this point in time. Externalisation of ideas or learning has focused more on writing, reporting and completing activities, with some uses of speaking and presenting, and less focus on drawing or moving (although some specific projects and activities have focused on aspects using software enabling movement of items on screen, using Kartouche software, for example). In these areas links to other forms of externalisation (and other technologies) are clearly important, such as using mobile devices to capture images of events and then taking these into a classroom to discuss in class via an interactive whiteboard (clearly exploited by some teachers in some projects).

At a metacognitive level, uses appear to be focused on detecting and correcting errors, and attention on what is needed, with some focus on relating what is known to material to be learned. Less emphasis appears to be placed on keeping place and sequence, pacing of work, or testing correctness of strategies. Limitation might be due to features of software accessible to learners, or lack of support in this area. Although file and folder systems allow learners to maintain place and sequence, and software features allow learners to try things out, learners do not appear to be using these features greatly; alternative more intuitive ways to support such aspects are worthy of consideration for future development.

In terms of motivational aspects, mobile technologies appear to be supporting pupil beliefs in and ways of working towards learning goals. Although academic efficacy appears to be supported in some respects (pupils discuss how technologies can allow them to tackle problems or activities, for example), the width appears to be limited at this point in time (perhaps because width of activities allowing this form of interaction is limited). Some project outcomes indicate that identified regulation is being supported (pupils clearly afford value to their learning when they are sharing this with their peers, parents and teachers). It is not clear how far intrinsic motivation to use mobile technologies to learn has developed, but this is clearly potentially linked to levels of encouragement externally (through extrinsic motivation). Society generally does not yet ascribe high value to, or state the necessity for, the use of mobile technologies to support learning, so teachers and learners cannot yet take a strong lead from society in this respect.

At the level of social interactions, uses of mobile technologies from a learner perspective have appeared to focus more on explanation and illustration, discussion, questioning, and initiating and guiding exploration. Learners have tended often to use mobile devices to support social interaction, without encouragement from teachers necessarily. More emphasis has been placed from a teacher perspective on instruction, explanation and illustration, direction, and initiating and guiding exploration. Less teacher emphasis appears to have been placed on social interactions concerned with demonstration, scaffolding, speculation, consolidation, summarising, or evaluating pupils' responses. It is clear that practices of social networking between teachers and learners need to be developed far more if learners are to benefit from relationships between informal and formal learning settings. Many learners recognise settings outside schools to be 'real', and benefit from learning in those contexts. Learners taking 'real' experiences into formal learning settings, to explore them, discuss them, and speculate with them, have been seen to gain from these forms of opportunity.

In terms of societal aspects of learning, mobile technologies are seen to support recreational and learning endeavour, while caring thinking appears to be supported at appreciative and active, but less so at normative, effective, or empathetic levels. Some teachers have encouraged learners to use mobile technologies to think about recreational as well as educational endeavour, about links to work and caring for others. However, such uses are not widely integrated into practice, and ways to encourage teachers to consider these aspects more widely is likely to be of benefit to learners.

Looking across the picture offered by this analysis, much of the current focus is on affordances that are in the cognitive domain. Learners have used affordances to support aspects of the social domain more than teachers have. Although any one activity cannot cover all aspects of learning domains, it is reasonable to expect activities across a period of time to support all aspects. Teachers need to offer activities across time periods that offer this balance. To address the current imbalance, mobile technologies need to support additional wider aspects of learning that encourage the development of the 'learning native' (i.e. students who use mobile devices to support their own learning ideas and needs, and are actively involved in all aspects of learning domains). Learners need participation in practices that integrate and support, from a learner and a teacher perspective: finding out about 'big pictures'; being encouraged to apply knowledge; to analyse, synthesise, evaluate, conceptualise, compare, reason, interpret, draw; to recognise how to select and understand appropriate strategies, keep place and sequence, pace work, test correctness of strategies; to gain an understanding that mobile technologies are recognised by society as learning tools, being encouraged to have and use mobile devices as and when appropriate, to engage in discussion with teachers; to question teachers; to gain ideas from teachers about scaffolding learning, speculating about ideas, consolidating, summarising; being given feedback from teachers; thinking about caring for others through the use of the devices; and exploring uses in terms of links to work.

CONCLUSIONS

Evidence available at this stage indicates that mobile technologies grasp the attention of many pupils and allow them to engage in acquisition of knowledge through a range of sensory routes. Pupils appear to retain certain knowledge and skills when using the facilities, are able to rehearse knowledge, and to recall it through a range of routes (supported, it appears, through high personal levels of ownership and modes of use). Resources uses support externalisation of learning strongly, through a range of routes, but this is even more effective when coupled with uses of other (including human) resources and technologies (within and outside school settings). A focus for learners on metacognitive and megacognitive aspects will depend upon modes of use, but some modes could enable transfers of learning (known to be important in terms of learning development generally), even more strongly than they are currently. Some social interactions are supported strongly through the use of this medium for learners, and it appears that this medium could support teachers effectively in a range of ways. Some societal aspects appear to be supported for some pupils, and the development of caring thinking by some pupils in some activities is a clear strength of this resource.

To develop the concept of 'learning natives', 'digital natives' need to be shown how to use mobile technology facilities to engage with and enhance learning in ways that go beyond that offered through other media. They need to be provided with methods and models that become a routine part of their armoury for learning exploitation. Some current activities suggest that mobile technologies should be used for data capture, exchange and sharing rather than using them just to undertake communication itself (see how devices were deployed in the Steljes case study, outlined above, for example). When young people use mobile technologies for social purposes they often share imagery, ideas, and thoughts that provoke discussion ('off-line' as well as 'on-line'). These actions stimulate engagement as well as promoting internal and external discussion. To this end, it is clear that certain uses of mobile technologies should be encouraged more. Studies report that mobile technologies offer facilities supporting learning through active engagement and communication, through forms of learning transfer, through supportive social interactions, and through development of supportive societal patterns. It is these forms of activity that need to be developed and exploited more, if mobile technologies are to provide support for learning in ways that other technologies can not provide. Practitioners and families should encourage activities such as "Snap and show" (pupils capture imagery, downloaded for whiteboard access and wider discussion, or it is made accessible to parents so that they can see and discuss what has happened in school, to perhaps develop ideas and examples with their children further), "Review and reflect" (pupils capture audio, imagery and video during lessons, which are used in plenary sessions to reflect on what has been covered, key elements learned, how these fit into wider pictures, and how ideas might be taken further beyond the classroom); "Think forward" (pupils access future topics via the internet and capture relevant thoughts or ideas for class or on-line discussions); "Listen to my explanations" (pupils record audio to complete home work assignments and verbal explanations are marked by teachers); "This is what I've done and how I've done it" (pupils create presentations of how they have used mobile technologies to tackle particular activities, they are recorded and made accessible on appropriate websites for others to see); "Tell me how I could improve this" (pupils share their work in multimedia formats with peers, mentors, teachers or trusted adults to seek evaluative feedback, assessments of their work, and actionable ideas for improvement). Learning elements focusing on communication, social and societal aspects are now being explored in practice; it is within this realm that mobile technologies could have the widest and most profound impacts.

This paper shows how 'mobile learning' can be described through emphases of current uses, and that while other affordances are provided by mobile technologies, these are not exploited to the same extents. If level of detail about a current status of application to learning domains is needed, then future studies will need to accommodate an identification of outcomes at such appropriate levels. This paper adds to this element of research discussion by offering a preliminary learning gap analysis, which could be expanded further (exploring specific age groups, for example). At this stage, levels of use of mobile technologies are far from widespread in schools, so it may well be possible to set up control group procedures to quantify levels of learning benefits arising. From evidence that exists currently, it can be argued that quantification of learning benefits needs to be undertaken. However, it is also clear that using mobile technologies to support learning approaches that cannot easily be undertaken through other media, or that lead to important learning outcomes, is arguably more worthy of quantitative research effort than one which would attempt to identify levels of benefit from a diffuse set of practices where learning focus is not detailed or defined (especially if there is to be a focus on the development of the 'learning native'). This suggests an approach through a series of stages: an evaluative identification of a range of practices that appear to offer benefits in these areas that could not otherwise be gained by using other technologies or media; a qualitative identification of the specific elements of learning that are arising; and a quantitative identification of the benefits using appropriate control and test groups. The analysis in this paper indicates worthy areas for exploration of impacts at this point in time: the transfer of learning; retention and recall; motivation in terms of learning goals; appreciative caring thinking; and the development of supportive informal and formal learning links. Research clearly has a potentially important set of roles to play in supporting development of appropriate practice. Not only can research studies identify the range of projects that involve effective mobile technology uses at a communication, social and societal level, but also their outcomes and significance arising. Overall, there is a clear need to explore in more depth not only the issues when integrating new technology such as mobile devices, but also the development of new pedagogical approaches to social and collaborative learning linking informal and formal education, which support the emergence of active 'learning natives' (those who are investigative, in spite of any certain educational limitations, where natural enquiry is supported by learning spaces offered by technology uses).

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Do Smart Devices Make Smart Learners?

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ABSTRACT
This paper follows up a paper presented at the mLearn 2007 conference (Kukulska-Hulme and Pettit, 2007). It reports on interview data gathered to complement the questionnaire findings reported in that earlier paper. Both papers relate to a study of participants who were each lent a smartphone, which they were encouraged to adopt and embed in their working practices as members of staff at The Open University. The interviews were intended to discover the detail of how participants used the new devices, and to explore which factors motivated and de-motivated them personally as they decided whether and how to adopt the device. Some participants already used a smartphone or PDA, and the findings therefore throw light on their willingness to substitute a loan-device for one they already owned. The study gives evidence of some of the participants' highly personal reactions to features of this particular smartphone, and their preferences in terms of which interventions and support were most effective. It also indicates that the wireless infrastructure was widely regarded as a critical factor in influencing adoption of the device. The findings from the interviews are relevant to a range of professional and educational contexts where participants are being encouraged to adopt a new mobile device and/or extend their mobile practices.

Author Keywords
device substitution; interviews; killer application (reverse); mobile device adoption; smartphone; wifi

THE PROJECT AND THE DEVICE

Forty members of staff at The Open University were each lent a Qtek smartphone and encouraged to use it for personal and professional purposes. Questionnaire and interview data were collected on their attitudes to the project design and the support structures, their reactions to the device, and their experiences of using it. The questionnaire data have been reported elsewhere (Kukulska-Hulme and Pettit, 2007). The current paper focuses on key parts of the interview data.

The touch-screen device was a Qtek 9100 from HTC Corporation. It uses Windows Mobile Version 5.0, and includes a range of software and functions such as word-processing (Word Mobile), spreadsheets (Excel Mobile), File Explorer, Internet Explorer, PowerPoint Mobile, games, calendar, contact information and a calculator. It incorporates – in addition to a phone – a camera with various forms of capture including sequences of images ('bursts') and video. It allows three ways of inputting data – typing on the slide-out qwerty keyboard (see Figure 1), using the stylus to tap the on-screen keyboard, and 'handwriting' with the stylus. In addition to its main storage area, the device was supplied to participants with a 1-gigabyte mini-datacard in the expansion slot. A portion of the card contained video recordings of an institutional workshop; project participants were encouraged to view these, and were permitted to load their own files onto the remainder of the card.

The device has wireless connectivity. Where wifi is available – as it was in participants' offices, for example, and at hotspots on campus – this permits users to browse the internet and access their email via Outlook Web Access. The project did not supply a SIM card, though participants were free to insert one and use it at their own expense. The smartphone is supplied with a CD containing software for synchronization: participants were provided with specially written guidance and screenshots to support them in installing this software on their desktop PC. They were encouraged to install it and to synchronize the smartphone and their PC at times of their own choosing.

RECAP: FINDINGS THAT WERE PUBLISHED EARLIER

Two cohorts, each consisting of twenty members of staff from the Institute of Educational Technology where the authors are employed, took part in the project. The first cohort participated for 5–6 months, after which the project design was adjusted before the second cohort started their engagement of 5–6 months. In our earlier paper (Kukulska-Hulme and Pettit, 2007) we discussed the design of the project and its underlying assumptions, and we reported on the questionnaire data gathered from the first cohort. The data indicated that participants learned about the device – in terms of getting ideas about its potential, and finding out how to operate it – from various sources. Sources included casual interaction with fellow participants, a buddy system initiated by the project, scheduled but informal drop-in sessions, and workshops (for which attendance had been stipulated) run by the authors of this paper. We noted that many participants had found it technically difficult, and in some cases impossible, to connect their device with the (free) wifi on campus, perhaps because of infrastructure difficulties. Some had commented critically on the look and feel of the device. We also noted that '[o]ver the five-month period, our participants did not move much beyond extending existing habits and using familiar facilities such as calendar, email, notes and camera'. However, a few participants 'had continued to explore new uses, for example connecting to wireless networks to pick up email on the move, experimenting with different means of text entry, creating a PhD thesis narrative outline, taking photos in a "do-it-yourself" store to record measurements for projects, and using RSS feeds to read on the move…'

We subsequently reported on the questionnaire data from *both* cohorts. This paper (Kukulska-Hulme and Pettit, 2008) explored in greater depth participants' responses about 'community, interaction and support aspects of their experience', and on the role of the device in their personal and professional development. The data provided greater insight into the positive role of appropriate support structures, the need to give participants more detailed device-specific advice at the start of the project, and the benefits of open discussion of social issues such as whether it was acceptable to use the Qtek in a meeting (and for which purposes). The data also shed light on the factors limiting the collaboration between participants, such as lack of time, individuals' attitudes, and lack of common objectives across staff in different roles.

Figure 1 (left): Windows menus on a smartphone similar to the one in this study. Right (Qtek 9100): the screen reformats into landscape when keyboard is pulled out. (Left: http://qtek-smartphone.handster.com/software.php?id=90&for=Qtek+Smartphone; accessed 10 April 2008. Right: http://www.gsmarena.com/qtek_9100-pictures-1257.php; accessed 14 April 2008)

RATIONALE FOR INTERVIEWS FOR THIS PAPER

The interviews, which were carried out after participants had completed the project, could obviously be expected to yield a richer picture – in comparison with the questionnaire data – of individuals' experience of the devices during the project. More specifically, we wanted to learn more about a range of issues, including the following:

- **The various ways in which participants learned about the device** – how to operate it, and what it was good for. The questionnaire data had indicated the relative importance and perceived value of buddies, informal groups, workshops etc, and had captured brief comments about how we had designed and implemented the project. We now wanted to hear how these events and groups actually engaged, or failed to engage, individuals, so we could learn more about the implications for design of future implementations and projects. What sparked participants' interest, understanding and enthusiasm? And was the learning incremental, or did it have major 'breakthrough moments'?

- **Their personal reactions to the device** – its look and feel. In their questionnaire responses, a number of participants had indicated their concerns in this area. We wanted to find out more: did any general picture emerge, or were the reactions highly individualized? The importance of such factors has been widely reported in the literature, and we had reported on some of these factors in a separate study (Pettit and Kukulska-Hulme, 2007). In that study we examined the highly varying ways in which participants (all of them alumni on our Masters programme) used their own mobile devices in their personal and professional lives; this links to the next bullet point below.

- **Comparisons with participants' existing devices, and new possibilities**. All participants reported they had previously used a mobile phone (cellphone), and we assumed that they owned one. Some reported using a PDA. We wanted to learn more, through the interviews, about how they decided whether to substitute the project smartphone for their existing device. We expected that the choice would not depend simply on whether the new device had greater functionality than their existing device: the look and feel, mentioned above, would probably play a part, as would the fact that the project phones were merely on loan, and participants would have to return them at the end of the project. Corlett et al. (2005), for example, reported on a 10-month trial in which higher education students were lent a mobile learning organizer. They reported considerable success, but noted that '[o]wnership of the technology is clearly important. While the PDAs are loaned, students are reluctant to invest time and money in personalising and extending them' (p.170). Milrad and Spikol (2007) reached the same conclusion in relation to the smartphones lent to students in their project. We wanted to find out whether a similar factor came into play in our project.

- **The detail of participants' usage, and how this related to their individual context**. 'Context' in this case would include the physical and built environment both on and off campus: participants were encouraged to use the devices in their professional and personal spheres and to carry the device with them off-campus if they wished to. The context would also include individuals' cultural and professional circumstances, such as the type of work and range of tasks that they carried out, whether they worked off-campus and, particularly important for mobile devices, how often if at all they used the device while travelling.
- **Problems related to wifi connectivity**. The questionnaire data had already indicated that these were significant. We wanted to use the interviews to learn more about how individuals were affected. Again, Corlett et al. report on this type of issue, indicating (ibid., p.162) that '[w]ireless connectivity was crucial to the usefulness of the organiser'.

METHOD: INTERVIEWS

For reasons of space, this paper reports on the interviews carried out only with the first cohort. Interviews with the second cohort will be reported in a later paper.

The interviews were carried out with ten of the first cohort of twenty participants. There were various reasons for limiting the number of interviewees to ten. Resources were one factor: one-to-one interviews, each lasting perhaps three-quarters of an hour and with a recording that can take a number of hours to transcribe, obviously demand considerable staff time. Another factor was that not all twenty of the cohort had persisted with the project: a few had stopped using the device in the early stages. Through the questionnaires we had captured some of their reasons for stopping, and we decided that in the interviews we would focus on those who had engaged more fully.

Participants had written their names on the questionnaires, and we were therefore able to use the questionnaire data to select those we would invite for interview. We selected those who seemed, on the basis of their questionnaire responses, to have developed interesting practices with the device and/or to have invested considerable energy in the project. That still left more than ten potential interviewees: we made our final selection on the basis that it should include both academic (faculty) and support staff (administrative and secretarial grades), and both genders. In volunteering for the project, all twenty members of the cohort had stated that they were willing to participate in a recorded interview and that their transcribed words could be quoted anonymously in publications.

The interviews were semi-structured. They included a common set of questions relating to key issues including the five bullet points above; for example, 'when you were learning to use the device, what or who helped you?' But each interview also contained questions where the interviewee was asked to elaborate on points he or she had already made in the questionnaires. These individual questions were agreed between the two authors of the paper and the researcher carrying out the interviews, with the interviewer having discretion to pursue promising areas as they arose in the course of an interview.

The interviews were carried out on an anonymous basis, although it must be recognized that interviewer, interviewees and transcriber were colleagues within a unit of c120 employees and were therefore known to each other and recognizable. Holstein and Gubrium argue that interviews are 'collaborative accomplishments' between interviewer and respondent (2004, p.141), although we are not hypothesizing as to whether this effect is stronger where interviewer and interviewee know each other. In a project of this kind it also seems likely – perhaps inevitable – that individuals' responses in interviews would be affected by the comments that fellow participants had made in workshops, informal meetings, buddy interactions and general 'corridor narrative' about the device and the project.

The interviews took place at the end of the project when the interviewees had already completed three questionnaires and when most of them had returned the loan-device. Interviewees were therefore being asked to provide their insights into a process that they had started at least six months before the interview. There are obvious limitations in retrospective accounts, and there are particular difficulties in researching the use of mobile devices in informal learning: see, for example, Vavoula (2008). Nevertheless we suggest that the interviews, taken in conjunction with the questionnaire data, provide a valuable component in the overall reporting of this study, particularly in their detail of individual uses and reactions.

INTERVIEW FINDINGS

The findings below are grouped according to the five bullet points above (under 'Rationale for interviews for this paper'). The separation is convenient at this point in the paper, although the elements tend to merge in practice. Interviewees are referred to by number – P1, P2 etc – and for the sake of anonymity are not identified by gender.

Learning how to use the device, and discovering what it's good for

Across the 5–6 months of the first cohort's participation, there were informal and leaderless lunchtime 'Qtek Clubs' every few weeks, where participants were free to drop in and share questions, concerns and tips. These rarely attracted more than one-third of the cohort, and often considerably less – although in the questionnaire mid-way through the first cohort's participation, 12 (60 per cent) reported having participated in at least one club meeting. Interviewees who had attended one or more clubs gave insights into how this type of event worked for them. For example, one interviewee (P1) stated that:

> 'The conversation there was quite encouraging and quite good, because you could try out things with your peers…And it was not too intimidating: rather than going to the technical people who know how, with your peers it's not intimidating because they are also talking about the sort of problems that you may have come across.'

P1 said more about the contrast between learning with peers at the clubs on the one hand, and on the other hand consulting the experts in the department's IT support unit. In relation to consulting the experts, s/he said:

> '…sometimes when you deal with people who…know IT, they just press buttons and things work out…and then you take [the device away] with you and it doesn't work again…you don't want to go back again, because it makes you feel that you are not listening when they tell you what to do…'

P8 was disappointed that most people did not attend the clubs – 'just core few, four or five at most'. Nevertheless s/he found that '[the club] was really good, because we each found different features, and so we could sort of try and help one another'. One thing s/he learned was how to make notes with the 'handwriting' function using the stylus. The crucial part of what she learnt, from someone who knew how to do it well, was that 'you have to be precise, you can't just scribble'.

P10 also found the meetings of the Qtek Club to be very useful:

> '…saying "I found out that it does this", and somebody else sharing that, and checking to see if it worked…I probably would have done a lot less than I did, if I didn't have…you know, my interest was sparked by somebody saying "Oh, it does this. Oh, I'll try that".'

P5 recounts how s/he helped a fellow participant to learn at one of the meetings of the club:

> 'She'd been trying to just do some voice recordings and capture the odd memo here and there and couldn't work out how to do it…and we sat and went through, "Right ok, you go to this part, and you can do it directly from the notes or you can set up the button on the side to do it".'

For P5 the overall learning process was incremental, 'not really a Eureka'. And s/he was largely self-taught: 'I'm quite good at fiddling around with things…and figuring them out.' S/he did not rely on the manufacturer's manual, preferring to 'try various things and see what works'. In order to find out how to synchronize to a Mac, s/he used Google to find an online forum. However, s/he did consult someone outside the workplace who was 'technology savvy'. P6 shared insights with a member of the family who had acquired the same device.

P8 deliberately chose, as a 'Qtek buddy', someone who was more technically experienced. Nevertheless P8 felt the learning was not all one-way:

> 'Yet I could help her as well, so it was like an interaction…we were saying, "Well, what do you think about that, and what do you think about that?" And "Let's try this and let's try that". And that's how we progressed.'

For P8 it was essential to have this buddy, 'because it gave me confidence…I think if you've got confidence to use new technology, you will. You will make the most of it.'

Participants' personal reactions: look and feel

Questionnaire data from the first cohort had indicated that eight of the 18 respondents (44 per cent) had not transferred their SIM card to the Qtek. Of the ten who made the transfer, half left it in the Qtek for the project's duration, with the remainder returning the card to their own phone at some point – perhaps after one attempt, perhaps after a few months. One who transferred the card into the Qtek reported in interview that s/he found the device 'clunky' (P8). P9 had a similar reaction:

> 'I found it difficult to use as a phone…it wasn't a very good phone…for hearing people. Certainly if you're in a loud place, partly because it's so big, and getting it positioned correctly on your head…'

For one interviewee it also had the disadvantage that – when used as a phone and held against the cheek – makeup or grease would be transferred from the user's skin to the device's screen. For P9 the device was too big/heavy for the pocket of a light jacket: 'the jacket would be down by your knees by the end of it.' S/he also reported that 'I almost never used the [slide-out] keyboard on my Qtek, which I was surprised by'; s/he used the on-screen keyboard and stylus. The keyboard (see Figure 1) adds to the depth of the device, yet it was redundant for this participant. P8 had a similar reaction: s/he used the on-screen keyboard and found that the slide-out keyboard was too small for his/her fingers. P7 transferred his/her SIM card into the Qtek, but found the latter cumbersome compared with a conventional cellphone. (The device weighs about 170g with battery; it measures about 109 x 60mm, and is about 24mm deep.)

For P4 the size of the device presented a different problem. S/he described an occasion when cycling home in the dark:

> 'I was in the city centre…and I had to call home to say I'd be late or whatever…just where I'd stopped I felt a bit vulnerable taking [out] this…chunky piece of kit…whereas, you know, my [conventional] phone doesn't attract any attention.'

For P10 there was an issue of complexity: s/he transferred the SIM card into the Qtek but was not sure how to use the Qtek as a phone, partly because there were other functions in the device: 'you know, it's so easy to…enable another function while you're just holding it…I think I have taken a photograph of my ear, actually.'

Substitution for a cellphone? For an existing PDA?

Users' reactions to the look and feel of the Qtek were one of the influences on whether they substituted it for their existing phone. Other factors came into play: given the Qtek's wide range of functions, the device could also potentially be a substitute for a participant's camera or PDA, for example. Even though the camera on this model had the relatively low specification of 1.3 megapixels, it appealed to some. P6, for example, while acknowledging its low specification, valued the camera for everyday use because s/he tended to carry the Qtek around for much of the day. The ability to attach 'fun' frames to images appealed to another participant (P8).

We mentioned in the preceding subsection that some participants did not use the keyboard, and that for them it merely added inconvenient weight and bulk. For P5, however, the keyboard gave an advantage in comparison with her/his own PDA, which did not have a keyboard and required stylus-based 'handwriting':

> '…the little keyboard made [the Qtek] so much easier. If I was walking my way to lunch and I suddenly thought, "Oh, I must remember to…", and with one hand it's quite easy to open up the device, type yourself a note…put it away. You don't have to stop and get out a paper and pen. It's…just much easier, and obviously that facility is not on [my existing] PDA, because it hasn't got a keyboard. [With my existing PDA it is] necessary to get the stylus out and almost write as if you're writing a note to yourself…so it's the convenience of having that as well, also made me use [the Qtek] a lot more, I think.'

For P6, too, the slide-out keyboard (though small) gave the Qtek an important advantage over his/her earlier PDA, which used a fold-out keyboard and was 'yet another thing to cart around'. The qwerty design of the Qtek's keyboard also gave an advantage over his/her current PDA:

> '…the one thing about any keyboard on a device that small [as in the Qtek], is that it's inevitably going to be really hard to type on. So you can't touch type. But you can still, at least, you know if the keyboard is in the right order, which it is on the Qtek, you can almost simulate touch typing. You know where…your fingers should go…Whereas the current device I'm using, the iPAQ, the keyboard is even more cramped and the numbers are actually doubled up on some of the letters which is intensely irritating…So for me the Qtek keyboard was about the best I could have imagined on a device that small.'

P5 valued the Qtek's greater memory in comparison with his/her own PDA:

> 'The main difference was that the Qtek had a lot more memory capacity…and I wasn't restricted on what I could put on it and use. So, for example, with the PDA that I've gone back to using now…it doesn't like it particularly if I put big Word documents on there, or anything with complex formatting. It…goes incredibly slow...'

For some, the combination of many functions in one device was off-putting. For P1, for example, the device had 'too many things'. P3 had a similar reaction: s/he had not used a PDA before and was 'overwhelmed' by the number of functions. This seemed to inhibit exploration of the device; the curve was too steep:

> '…because I hadn't used [a] PDA before, I couldn't work out which parts of the application would be useful for what…There were so many things that it could be useful for, that I'd have to do a lot of playing around…I just thought, "Have I got the time to do this today?", and I continually put it off.'

P3 suggested that a simpler PDA might provide a better starting-point:

> '…I wonder if it's because I haven't had a PDA before, but I think…it was a big step going to Qtek, which is the, you know, fancy end of the spectrum…It might be nice to try a more simple version.'

P9 came at this question of simplicity/complexity from a different angle, in a comment that relates to the way in which one device might be substituted for another, or alternatively might dovetail with existing devices. As reported above, s/he found the phone too big and heavy; this was probably largely due to the keyboard. But s/he also commented that 'they are trying to shoehorn everything into one at the moment'. S/he would have preferred something 'more phone-like…what I would like to have is a single device that was calendar/phone/music. But…what I don't need is a replacement for a laptop'.

Finally for this subsection, it is worth a reminder that – in addition to issues about weight and size, slide-out keyboards, and the pros and cons of various functions – confidence in a device's reliability is important when participants are deciding whether to use the device for storing data. P5's confidence 'dissolved' when s/he encountered a technical difficulty and could not access the diary: 'at that point I went out and re-instated my filofax.'

How interviewees used the device

In earlier subsections we've reported some of the ways in which participants used the device: making notes, for example, and taking photographs. The calendar was used by several participants. Some also reported using the Qtek to carry documents and emails: P9, for example, valued the drag-and-drop File Explorer, which was noticeably easier than on a previous PDA, and s/he used it for transferring documents and particularly music from PC to Qtek. This same participant also managed to download emails via wifi, which s/he described as the most valuable and interesting use of the device. S/he then read the emails in a way that exploited the 'any time any place' potential often claimed for mobile devices:

> 'if I was in town, routinely I'd wander into [a location with open wireless], either get a coffee or not, or sometimes just stand in the foyer and download my email; and get on the bus and read my email on the bus coming home. And I found that extraordinarily useful, as sort of making use of these little moments of time. Otherwise I might have read a paper on the bus or something.'

P8 reported taking delivery of emails by synchronizing to the desktop computer, and then taking the device and reading the emails later: for example, 'I could look at them at home and see what was urgent'. P5 used synchronization to send emails; s/he would write them on the Qtek, but tended not to use the wifi connection to send them: 'It seemed to drain the battery a lot if I left it on.' Instead, s/he sent the emails to the Outbox from where they would be sent the next time the device was synchronized with the PC.

Wireless connectivity

Not all participants were as successful as P9 in connecting to the internet for browsing and emailing. Indeed this issue caused great frustration for many: 'it affected the whole thing for me', said one. P5 made a similar point, speaking of the enthusiasm at the first workshop at the beginning of the project where participants were introduced to the device:

> 'the first meeting where everybody had just got their devices and it was quite new and fresh, and not trying to [criticise] it in any way…but a new toy for people to play with…and we were all looking at the capabilities and the potential of them. I think at that stage people hadn't really encountered the technical issues...'

From a separate communication, it is clear that these 'technical issues' included the difficulties of achieving wifi or GPRS connection, and P5 found this issue seriously discouraging: 'that's what really made me think this isn't as wonderful as I'd hoped it would be.' At least three others reported difficulties and frustration with the wifi connection. P10, for example:

> 'I reckon I must have wasted hours trying to get on the internet, you know everything was so slow…It would have been better just to walk to your PC, or a hot desk…and do it that way.'

It is not clear how far the difficulties stemmed from features of the campus infrastructure or from aspects of the device or its settings, although that distinction is of course largely irrelevant for those individuals struggling to get connected. The difficulties prompted P5 to work with two others. One was P5's partner, who struggled to connect to their wireless network at home: 'I think [the Qtek] nearly went across the room a couple of times.' The other was a colleague:

> '[we had] a little session where we wandered up and down the corridor…and said, "[Wifi] works here. No, it doesn't work here". So that was a nice way of…sharing what we'd got.'

DISCUSSION

A number of themes have been presented in the interview data above. Their emergence was not inevitable or 'natural': they surfaced in an iterative process of reading and re-reading transcripts, of creating strands of enquiry, and of identifying evidence to cluster around those strands. The earlier questionnaire data will inevitably have influenced that reading process as well as shaping the initial set of interview questions. There is a sense – not surprising – in which the process sifted out the themes that the authors of the paper were looking for. Different themes may well emerge if the transcriptions are revisited.

Peer learning in the Qtek Clubs

With those caveats in place, we believe that findings of this kind are valuable in the detail they provide, and in the affective colour they bring – for example, the strength of feeling about the difficulties with wifi connection, or reactions to the Qtek Clubs. On that last point, the questionnaires indicated that most participants did not attend the clubs, whereas the interviews give considerable insight into the value of the clubs for some of those few who attended. For them, as reported above, it was precisely the fact that the peers in the club were not considered experts, and were not from the IT support unit, that was so valuable. The concept of vicarious learning is useful at this point, with its Vygotskian insights into the benefits for learners of observing and listening to others who are at the same point of learning or are just one or two steps ahead (see, for example, Stenning et al., 1999). Conceivably, too, the social and environmental structures were important in these clubs: sitting on chairs in a circle, with each person using a device and no-one acting as formal leader, is a different learning experience from going to consult an IT expert when one ‘has a problem’ with a device.

Having said that, it is important to stress that most participants did not attend the clubs, and so the implications for the design of future projects are uncertain. The authors of this paper promoted the clubs as voluntary drop-in sessions, and rarely participated; the issues that surfaced were those raised by the participants attending the sessions. Alternative designs could involve advertising a topic in advance, and/or finding a participant willing to prepare some teaching or provide some leadership on that topic. In addition, participants could be encouraged more strongly to attend – quotations from those who attended clubs in the current study, for example, might be persuasive in the future. But it is not obvious that participants would be willing to find the additional time, especially with a relatively loosely structured project of this type. In data not reported above, some participants commented that they would have liked greater structure – more pressure to attend clubs, for example, and printed or online support material providing a sequence of guided exercises. However, we feel it would be fruitful to explore ways of promoting club-type learning while not compromising its essentially participant-led nature. There are numerous user-led online forums for particular devices, and it would be valuable to compare them with the Qtek Clubs.

The reverse killer app?

The above posits the value of peer learning. However, it is also clear that there was an important role for expert input to help participants to connect to the wireless networks. The wifi infrastructure was improved early in the project, and at least one participant received detailed help from the IT support unit. Nevertheless problems remained, for reasons that are not entirely clear but are not necessarily linked to the device’s hardware. What is clear is that this difficulty was a major disincentive for some participants, even though they were willing to persist and to ask for help from colleagues and friends/family. For some, it became what we have called a ‘reverse killer app’: rather than being the winning application that would enable a device or a usage to triumph, it became the failure that would kill at least some of the initial enthusiasm for the device and for the project. The fact that a number of participants persisted and ultimately failed, suggests that they recognized its potential (a potential that P9, reported above, was able to exploit). The interview data provide a particular insight into the profound impact that a failure of this kind can have, even though one can also recognize that some participants developed ‘non-wifi’ ways of using the device to bring flexibility into their email practices – by synchronizing with their desktop computer.

Choosing a device for a project

The study highlights the difficulty of selecting a device. Given that phones and PDAs have been widely adopted for several years, participants are likely to have pronounced tastes and patterns of usage. Harnessing or breaking into these patterns is likely to be difficult. This applied to many participants in relation to the phone function of the Qtek: over half either decided not to transfer their SIM card into the Qtek or reverted to their existing phone before the project was finished. This was perhaps not surprising. What proved harder to predict were the reactions to the slide-out keyboard (the keyboard had been one reason for buying the device for the project). The keyboard was as attractive to some as it was an encumbrance to others. If we had consulted participants about which device to buy, this would not necessarily have resulted in greater satisfaction.

In terms of encouraging participants to adopt the ‘PDA functions’ of the device, there is evidence in the interview data that participants who already used a PDA tended to appreciate the capability of the Qtek: some stated that it was an improvement compared with their own existing device. For those who had not used a PDA, there is a suggestion that the relatively high specification of the Qtek at the time was off-putting: there was too much to learn. It is often argued that users of desktop computers exploit a very small percentage of the capability. This may not worry them, but a mobile device wears its functionality more explicitly – and this may therefore be more challenging and intimidating. The proposal from one interviewee was that a simpler device would have been a better place to start – hence the suggestion in the title of the paper that smarter devices may not encourage smarter learning.

Overall the study highlights some of the issues involved in introducing a new loan-device into the lives and work patterns of users who have already made choices – often backed up by spending their own money – about which devices they need and how they will use them. In relation to learning and mobile devices, Jones and Issroff (2007, pp.248–9) emphasize the importance of facets of ownership – ‘physical ownership’ of the device, for example. This adds complexity to a project of the kind reported here, where the devices were on loan and had been chosen by the researchers.

The characteristics of the Qtek device, not least its look and feel, were also crucial in whether participants adopted it, and for which purposes. While some participants barely engaged with the device after a brief period, some persisted for much or the whole of the project. In addition, across the total of 40 participants from the two cohorts, seven (18 per cent) volunteered to retain the device and to continue to use it for the second phase of the project. That phase will be reported in a later study.

On not categorizing the participants

It will be clear from this paper and earlier reports that we did not attempt to characterize the participants in terms of their attitudes to the adoption of new technologies. For example, we did not use Rogers' typology of 'innovators, 'early adopters' and so on (2003, with many earlier editions), which has influenced much of the literature in this area. Partly this was because of the difficulties of doing so, and partly because of our view that this would not be helpful. Kirkpatrick, for example, has argued (2001, p.175) that 'I believe we must be careful not to generalize about "staff" or to view staff simply as categories such as resisters, disciples or gurus and that we [should] not assume academics to be passive in the process' – a position with which we agreed. Rather the project focused on which elements would enable participants to learn, and what types of support would be valuable if participants were to embed the devices in their lives. If this sounds self-consciously benign in comparison with Rogers – whose typology is sometimes (mis)used to condemn and criticise – then it was also based on a pragmatic approach in a project with limited resources.

CONCLUSIONS

The paper has highlighted the value of interview data in elucidating the factors that influenced whether and how the participants used the smartphone. It has provided evidence of the value of the peer learning that took place in the Qtek Clubs, while acknowledging the paradox for researchers of trying to promote and organize participant-led activity. It has also provided evidence that the difficulties with wifi connectivity were a major source of frustration that threatened the goals of the project. Finally it has illustrated several of the ways in which the device was used.

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Pervasive Learning System Based on a Scenario Model Integrating Web Service Retrieval and Orchestration

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ABSTRACT

We are interested in learning and working scenarios integrating web service retrieval and orchestration in pervasive TEL systems in a learning situation at workplace. This paper proposes a context-aware model of a scenario for corporate learning and working activities in e-retail (shops and hypermarkets). This scenario model enables us to select how to achieve activities according to the current situation. We outline the semantic description of web services to enable the selection and, if necessary, composition and execution of web services to achieve objectives specified by learning and working activities. We propose a context-aware and adaptive model for pervasive learning systems. This model enables the selection of the relevant methods or services to realize activities according to the current situation. Moreover, we also build and develop an Intelligent Selling Space (ISS) architecture that serves as an infrastructure for service management and execution in e-retail environment.

Author Keywords

Pervasive learning, Context-aware, Adaptation, Task/method paradigm, Hierarchical task model, Service description, Service requirement, Learning and working situation

INTRODUCTION

Nowadays, technology-enhanced learning (TEL) systems must have the capability to reuse learning resources from large repositories, to take into account the context and to allow dynamic adaptation to different learners based on substantial advances in pedagogical theories and knowledge models (Balacheff, 2006). It is particularly true in mobile learning. Thus, several expressions are used: pervasive, ubiquitous, mobile, ambient and nomadic learning systems. It is necessary to clarify their meaning. We consider that these expressions are synonymous. They are used for highlighting a specific property in learning systems (Brodersen, Christensen, Gronboek et al., 2005; Sharples, 2005; Hundebol and Helms, 2006; Siobhan, 2007). Generally, such types of learning systems have all the properties of mobile, pervasive and ubiquitous computing. Many definitions of pervasive learning are given in literature (Jones and Jo, 2004; Bomsdorf, 2005; Hundebol and Helms, 2006; Siobhan, 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). Virtual Learning Environments are built according to a Service Oriented Architecture approach. It facilitates the deployment of adapted learning environment based on the aggregation and orchestration of the services needed by an organization. This approach can be very effective for pervasive learning environments if one considers a continuous adaptation based on the available services and other contextual information.

We are interested in the following issues: combination of formal (at school) and informal (outdoor, at home, at the workplace etc.) learning, integration of mobile devices in broader educational scenarios, context-as-construct and seamless learning across different contexts (Balacheff, 2006; Sharples, 2006). Moreover, the p-LearNet project (p-LearNet, 2006) has to integrate context-aware corporate learning and working activities in a particular framework: the e-retail (retail activities through shops and hypermarkets) framework. Scenarios are used to describe the learning, working and tutoring activities to acquire some domain knowledge and know-how or to solve a particular problem or to support working activities. Scenario analysis reveals that learning and working situations can be modeled by an explicit task model because working and learning activities are well structured and stable. In pervasive learning systems, activities, represented by tasks, can be achieved in a different way according to the current situation. Methods associated to tasks, enable us to provide different ways for carrying out tasks. Activities need to have access to resources or web services to be performed. Thus, a context-aware and adaptive mechanism is necessary to select relevant content (methods associated to a task, resources and web services).

The main contribution of this paper is an adaptive and context-aware model of a scenario integrating web service retrieval and orchestration based on an interdisciplinary approach (education, computer science, social sciences, and business) for a pervasive learning system supporting working and learning activities. The scenario model is based on a hierarchical task model having the task/method paradigm. An activity, represented by a task, may have several associated methods. A method represents a way to perform a task in a particular situation. The context-aware and adaptive mechanism can be viewed as the selection of the relevant content for a given task according to the current working and/or learning situation. This mechanism is based on the matching between content description and the current situation for filtering, annotation and ranking purposes. Content and situation need to have corresponding features for adaptation. Methods are described by contextual features while resources and services are described by metadata. Situations are described according to a context model. For managing web services, we also define the service requirement specification for web service retrieval. Besides, a generic ISS infrastructure based on Open Services Gateway initiatives (OSGi) and Universal Plug and Play (UPnP) is also proposed for web service orchestration and execution in workplace environment.

First of all, the p-LearNet project and e-retail system goals are presented. Secondly, a context management model (organization, features) is detailed and linked to a situation. Thirdly, we present our scenario model and its relationships with the context management model. Fourthly, the context management, i.e. the detection and creation of new situations are explained. Fifthly, the web service requirements and specifications are presented and also the semantic metadata schema describing the web services. Sixthly, we present our service execution architecture that serves as a platform of service management in e-retail systems. Seventhly, the adaptation process which links the context model, the scenario model, the metadata schema and the context management is presented. Finally, the conclusion highlights the main results of this study and some perspectives.

P-LEARNET PROJECT AND E-RETAIL SYSTEMS

At first look it seems that the traditional retail industries are not heavily impacted by Information & Communications Technologies (ICTs) in their relationships with the customers. Obviously ICTs were found in back-offices of the retail places, i.e. in the Supply Chain Management (SCM) systems, or in the Point of Sales (Paris, Wu, Linden et al.) for the payment phase more than two decades ago. But in fact the attentive observation of the different retail places shows us that there is more and more presence of ICTs in direct interaction with the customer, with a large diffusion of electronic displays of different formats: from very small monochrome LCD used as tag-price to very large ones used for dynamic advertising. But these uses are not truly interactive. We can also notice other more interactive systems allowing customers to check product prices, or to listen to the content of music CDs, by scanning barcodes, or even selecting the right ink cartridges for ink-jet printers by interacting with tactile displays placed across related shelves. In fact the diffusion of ICTs within future retail places is becoming more and more pervasive.

In such a framework, the main issues of the p-LearNet project are: work-integrated learning and customer learning support, continuous professional training at the workplace, professional learning whatever the place, the time, the organisational and technological contexts of the individual or collective learning and working processes, context-as-construct and seamless learning. In this project, our corporate partners are retail international companies having chains of shops and hypermarkets. The design and engineering of pervasive learning systems must be considered as an interdisciplinary problem requiring the integration of different scientific approaches from computer science, education, commerce, social sciences, etc. While learning focuses mainly on how to support individual and group learning processes through pedagogical guidance and how to enhance the learner's knowledge. The corporate partners at workplaces identify the problems and requirements about quality and efficiency of information and services to increase market share and the corresponding learning goals. In such a framework, several innovative scenarios have been set up according to two main learning and/or working situations for a seller and a customer as learners: i) Seller or customer, outside the shop counters: seller in the back office or storage areas, client at home or elsewhere; ii) Seller in his department, alone or with a customer having resources from the Smart Spaces surrounding them (large LCD screen, printers, RFID, etc.) (Derycke, Chevrin and Vantroys, 2007).

From a technical point of view, we define the seller's workplace as an Intelligent Selling Space (ISS). It appears that ICTs have allowed the development of a new form of commerce called e-commerce with already several variants enabled by new technologies, such as Web 2.0, Semantic Web and mobile communication and nomad objects which enrich the interactions and relationships with the client, and augment his/her experience as a user, and finally allow more sophisticated marketing strategies such as the mass One-to-One relationships.

CONTEXT MODELING

There have been numerous attempts to define the notion of context in different fields. We mainly focus on definitions giving the relationships between the physical world and users' activities. We claim that activities embedded in a particular physical world (or environment) are key issues to give us intention and meaning according to different situations and finally to determine the relevant features describing the different situations. These definitions are as follows: *"learning context is used to describe the current situation of a person related to a learning activity; in addition to attributes relying on the physical world model"* (Derntl and Hummel, 2005); *" information and content in use to support a specific activity (being individual or collaborative) in a particular physical environment"* (Kurti, Milrad, Alserin et al., 2006).

In pervasive learning systems, a context management model must the following properties: dynamic and "context-as-construct". According to Dourish, context can be viewed as an interactional problem: i) Contextuality is a relational property that holds between objects or activities; ii) The context is not defined in advance. On the contrary, the scope of contextual features is defined dynamically; iii) Context is an occasioned property, relevant to particular settings, particular instances of activities; iv) Context arises from the activities. Context cannot be separated from activities. It is actively produced, maintained and enacted in the course of activities (Dourish, 2004). In "Big issues in Mobile Learning", context is viewed as "context-as-construct", i.e. "context should be reconceived as a construct that is continually created by the interaction of learners, teachers, physical settings, and social environments" and "learning not only occurs in the context, it also creates context through continual interaction" (Balacheff, 2006).

Context management model

Our context model has to consider the context-as-construct property, the combination of formal (at school, for professionals) and informal (outdoor, at home, at the workplace etc.) learning, the integration of mobile devices in broader educational scenarios, and seamless learning across different contexts. Our context management model is composed of: i) a context model, defining a set of relevant context features (represented as triplets) and their structure; ii) a set of views, a view consists of a subset of context features which are relevant to a given content category (methods, resources, or web services) and a given domain (at present, learning or working) for adaptation. An adaptation process does not manage the same features for different content categories. In the adaptation process, the current situation, filtered by a view, and the corresponding content description are compared; iii) a set of situations, organized in historical dependencies. A situation is a partial instantiation of the context model consisting of the obtained features describing the current learning or working situation and its physical environment. A user activity can be influenced by his previous work and learning activities. As soon as a new situation occurs, the next activity or the activity continuation can be chosen according to the historical dependencies, for instance, to ensure seamless learning.

Definition 1(Context management model): Let *CMM* be a context management model, $CMM = <CM, CV, S, P>$, *CM* be the context model that is composed of dimensions $CM= \{d_1, d_2, \ldots, d_n\}$, where n is the number of dimensions and d_i is a context dimension; *V* be a set of different context views $CV = \{cv_1, cv_2, \ldots, cv_m\}$, where m is the number of views, cv_i is a context view. Each cv_i is composed of a set of properties from different dimensions in terms of their usage relating to a domain type, *S* be a set of situations (or historical situations) $S =< \{s_1, s_2,\ldots, s_p\},\leq_s >$, where s_p is the current situation. A total order $\leq_s$ on *S*, where $s_i \leq_s s_j$ implies that the situation s_i precedes temporally the situation s_j, *P* be a set of predicates that is used to manage situations including: the change, detection, creation, storage.

Definition 2 (Context dimension): Let d_i be a context dimension, $d_i \in CM$, $d_i =< d_i^c, d_i^m, d_i^p >$, $d^c{}_i$ be a set of characteristics, each of them is defined by a name and a domain, $d^m{}_i$ be a subset of context metadata associated to the dimension d_i that is used to manage the dimension d_i, $d^P{}_i$ be a subset of predicates, used for managing the dimension d_i. These predicates use metadata in $d^m{}_i$ and dimension characteristics in $d^c{}_i$.

The context dimensions are divided into two categories: abstract dimensions and atomic dimensions. An abstract dimension can be recursively broken down into sub-dimensions which are either abstract or atomic. An atomic dimension only consists of a set of characteristics. Our context dimensions are the scenario (a hierarchal task model having a task/method paradigm), the user (a user can be a learner, a teacher, a salesman, a customer, etc.) with sub-dimensions: the role, previous knowledge, know-how, preferences, loyalty card, purchase intentions, intention of use), the device, the location (place, co-ordinate), the time, the pedagogical tools, the network, the physical environment and the resource (learning object, services, media resource, system resource, etc.). The management of a context dimension (abstract or atomic) is described by context metadata. It is a set of attributes used by predicates *P*.

Definition 3 (Context view): A context view $cv_i = < P_i^{cv}, AT, CC >$, where P_i^{cv}, $P_i^{cv} \subseteq CM$, is a subset of properties from some dimensions or dimension features to describe a viewpoint related to a particular activity type $AT \in \{learning, professional\}$, and a content category $CC \in \{methods, resources, webservices\}$.

Context views are used to define different viewpoints for adaptation. Consequently, different adaptation categories and seamless learning strategies are specified accordingly.

Pervasive learning situations in the workplace

A learning situation in the workplace is composed of physical environment, learning and commercial setting of the user's current work situation. Several context dimensions are combined to describe different pervasive learning situations. In a formal way, a definition of the situation is given as follows:

Definition 4 (Situation): Suppose s_i is a pervasive learning situation in workplace, $s_i =< (e_{i1}, e_{i2}, \ldots, e_{ik}), t_i^s, t_i^e > \in S$ defines a complete context state associating all interactions between the user and the learning system in the workplace in a given time interval. It is specified temporally with a starting time $t^s{}_i$ and an ending time $t^s{}_j$. e_{ij} is a dimension characteristic in s_i. It is acquired as follows: automatically detected by the learning system or gathered from interactions between the user and the system or dynamically inferred or generated by the learning system (based on inferences or adaptation rules defined in the adaptation model). A situation and its historical dependencies are used to select and/or to continue an activity according to the scenario model.

SCENARIO MODEL

The main role of a scenario model is to integrate mobile devices in broader learning and working scenarios, formal and informal learning and to enable us to manage seamless learning across contexts. As a scenario describes all users' activities (with or without mobile devices, formal or informal learning activities), an author can manage a global activity consistency to deal with the previous mentioned issues. Several research studies in artificial intelligence focus on the hierarchical task model using the task/method paradigm (Wielinga, Velde, Schreiber et al., 1992; Trichet and Tchounikine, 1999). In learning environment, hierarchical task models were also used for designing, for instance, authoring tools (Ikeda, Seta and Mizoguchi, 1997), learning systems (Betbeder and Tchounikine, 2003; Ullrich, 2005). The mechanism of hierarchical and recursive decomposition of a problem into sub-problems is one of the basic characteristics of the hierarchical task model (Wielinga, Velde, Schreiber et al., 1992; Trichet and Tchounikine, 1999).

The task/method concept

Within the framework of the Task/Method paradigm, tasks represent activities and sub-activities managed by a knowledge-based system. A method describes how a particular task can be achieved. There are two types of tasks: abstract task and atomic task. An atomic task is not composed of sub-tasks. It can be achieved by a simple procedure defined inside a method. An abstract task represents a high level activity composed of sub-activities. A method defines how an abstract task is composed of sub-tasks which can be abstract or elementary tasks. For a given task (abstract or atomic), several methods can be used to accomplish it. Methods are described by contextual features for adaptation and selection. It is composed of a property set according to the corresponding context view.

A Method, associated to an abstract task, defines a control structure which allows the recursive decomposition of tasks into sub-tasks and the sub-task order at runtime - by means of operators. At present, three different operators are used: sequence, alternative and parallel. A Method, associated to an atomic task, can have: i) a resource specification for resource retrieval; ii) a service specification for web service retrieval; iii) a procedure/function specification for a simple procedure or function.

Learning scenario for workplace

Pervasive learning scenarios in the workplace are modeled by a hierarchical structure of tasks/methods representing learning and working activities. For a complete presentation and execution of the scenario, another category is needed: mixed activities. Thus, working and learning activities are represented by working, learning and mixed tasks. In Figure 1, the contextual features and the control structure of some methods are represented for different categories of tasks.

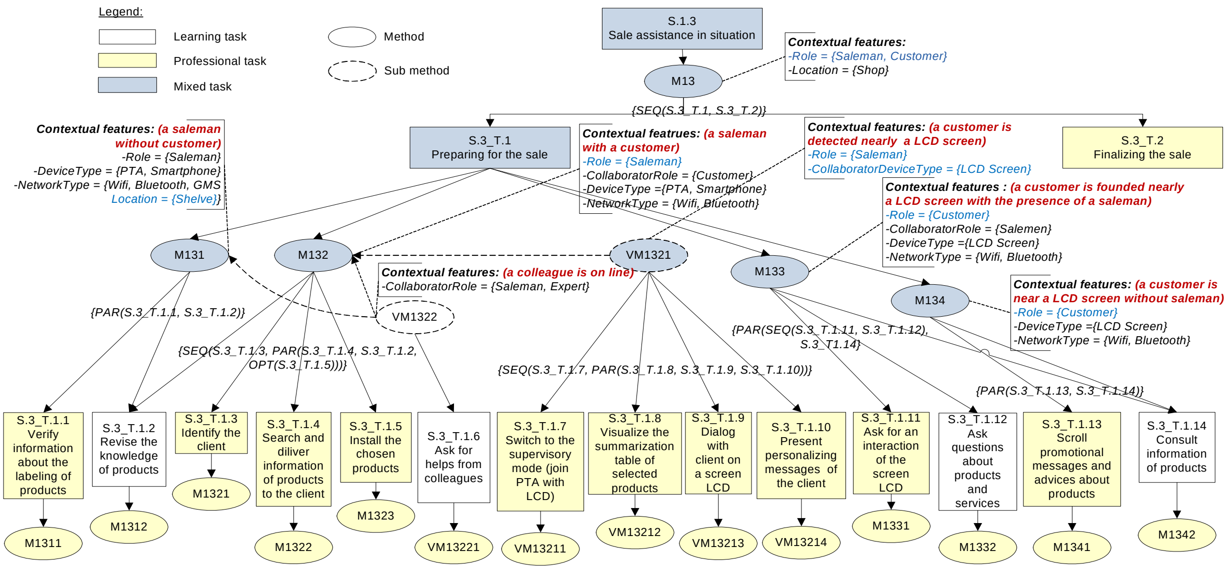

Figure 1. A small part of the e-retail scenario

Figure 1 shows a part of the e-retail scenario, which represents the decomposition of the mixed task "S.1.3 – Sale assistance in situation" by a method "M13" in a sequence order of sub-tasks ("S.3_T.1" and "S.3_T.2"). The decomposition of the task "S.3_T.1" is made by several methods ("M131", "M132", "VM1321", "VM1322", "M133" and "M134"). Each one is associated to a set of contextual features, which specifies the relevant situations for which the method could be selected. Because the task "S.3_T.1" is an abstract task, hence its methods decompose it into sub-tasks by means of operators determining the sub-task execution order. The method "M131" aims to provide the seller with both activities available ("S.3_T.1.1 - Check the information on the product label" and "S.3_T.1.2 - revise the product knowledge") when he approaches to shelves without customers (Location = {Shelve}). The method "M132" achieves the task "S.3_T.1" for the seller with a customer (CollaboratorRole = {Customer}). It is divided into four sub-tasks that are carried out as follows: (SEQ (S.3_T.1.3, PAR (S.3_T.1.4, S.3_T.1.2, OPT (S.3_T.1.5)))) means that we start with the sub-task “S.3_T.1.3” then follow with one of three sub-tasks ("S.3_T.1.4", "S.3_T.1.2" and "S.3_T.1.5") that will be executed in parallel.

Both methods "VM1321 and "VM1322" are the specialized methods which are added to one (or several) other method. The method “VM1321” is aimed at providing the seller with ways to switch his PTA to the supervisory mode when a large LCD screen is available. This method is coordinated with the method "M133" which is designed for the customer (Role ={Customer}) to provide him interactions with the LCD screen. Thus the method “M133” is seen as part of the method "M132". The method “VM1322” aims to provide the seller with a collaborative activity that allows him to ask his colleagues for help or advice on the product or the situation. The methods "M133 and M134" are designed for a large LCD screen (DeviceType ={ LCD screen}) and a client (Role = {Customer}). It is dedicated to the LCD screen to provide interaction functionalities to the customer, so the customer can interact and communicate with the seller according to his requirements. While the "M133" is for the seller (CollaboratorRole = {Saleman}), the "M134" is reserved for the customer who is alone in front of a LCD screen.

CONTEXT MANAGEMENT PROCESS

To solve complex and dynamic context changes and the demands of situated learning, the learning system detects the situation changes. The context management process generates a new situation or updates the current situation for maintaining activity relevance and continuity. This process is divided into five main stages: i) Stage 1: Context change detection and aggregation: this stage determines context changes and checks whether these changes lead to the creation of a new situation or an update of the current one. The changes can come from collaborators (colleagues) or customers or tutors or learners - user interactions, location, network, device, time, scenario, etc.; ii) Stage 2: Gathering of the initial context information to create the new situation, this is done by a partial or complete copy of the last situation and/or by querying the context ontology; iii) Stage 3: Selection of the current task: the last task status can be restored in the new situation to ensure seamless learning and working based on the historical dependencies of situations. When the last task is finished, the next one is selected according to the current scenario and the historical dependencies of situations. When the last task is not finished, it is necessary to continue it; iv) Stage 4: Searching for the relevant couples (Task, Method): According to the current situation and the task, the adaptation process has to select the relevant methods. The main role of the adaptation process is to maintain consistency between the learning system, the physical environment and the current learning or working situation and also to ensure seamless learning and working; v) Stage 5: Discovery and execution of relevant web services to serve the current task: Realization of a task requires the discovery, orchestration, invocation and execution of relevant web services. Service requirement specification which specifies the required service functionalities and characteristics is defined in the selected method of the selected Task/Method pair in stage 4. The adaptation process is hence aimed at searching for the relevant web services to realize the current task according to this specification and the current situation. The specification and management of web services is described next.

SERVICE SPECIFICATIONS AND REQUIREMENTS

In our learning and working scenarios, an activity may be realized by either a simple internal or a set of external services. The problem to solve is to search for a service or a number of services that may be composed in certain order to fulfill the requirements of the current task. Towards this goal, services have to be semantically annotated. In systems without context adaptation, web services are statically bound to a method during design time. In this regard, the problem is to bind, invoke and execute these web services in a “known” order. Take for instance Task “S.3_1.4” in Figure 1 above, web service A can be bound to this task (through its method “M1322”) at design time for searching for product information and resources (images, sound messages, documents, etc.). At runtime, logics are built-in to web service A to search for relevant resources annotated with description metadata from repositories or from the database and deliver them to the client of the task making a request.

The solution that we propose in this paper is semi dynamic service searching and matching. The relevant services in this regard can be a single matched service or a set of matched services. The latter is aimed at searching for all the relevant services provided by service providers according to current situation and the service requirement identified in the selected method. This is done based on an adaptation process applied to services (Please refer to Context Management, Service Requirement Specification and Adaptation Process sections). Taking Task “S.3_1.4” above for example again, the realization solution consists of four phases. Each phase is considered as a single service or a set of matched services: i) Phase 1: a search of web services, which provide information of a selected product or a product type required by the Service Requirement Specification of the method “M1322”, on a service repository is first carried out according to the current situation. ii) Phase 2: All relevant web services of all the suppliers are organized, invoked and executed for searching for product information and resources. iii) Phase 3: The found resources are assembled and adapted according to the current situation. They are filtered and sorted according to their degree of relevance. iv) Phase 4: To display and/or deliver the relevant resources to the targeted peripheral devices. All services are managed and executed by our ISS architecture described later.

Service requirement specification

Characteristics and functionalities of a service required for a relevant task or activity have to be specified semantically to facilitate accurate and efficient discovery and matching of the right services. The primary goal of a service requirement is the description of how a service is to be "desired". It is a request issued by the system wishing to interact with a service provider in order that a task should be performed on behalf of the learner in the current situation. By our definition, a service satisfies a service requirement by providing a set of desired output parameters for a desired goal with a set of pre-existing input parameters and situational context features.

Our proposed service requirement is summarized as follows: 1) Functional requirements: describe the capabilities of web services desired by a user. It is characterized by input parameters, expected output parameters, pre-conditions and expected post-conditions; 2) Non functional requirements: include the identity of a service (e.g. name, owner, type etc.) as well as implicit performance related characteristics, such as Quality of Service (QoS), security etc; 3) Content requirements: specify a list of domain concepts or a query identifying the content requirements of services (e.g. Mark, Price, ProductModel etc.).

Service description

Service request and provision are modeled with a common service description metadata model to formally specify the functional and non-functional requirements of services. The fundamental consideration in describing a web service to support accurate and efficient service discovery and matching is to fulfill a three-part ontology (Milanovic and Malek, 2004): *function*, *behavior* and *interface*. *Interface* dictates how the service can be invoked and what resources are to be assembled to provide the desired functionalities of the service. It is syntactic in nature. We propose to follow the WSDL binding standard for message format and protocol details for interoperability. Hence, the problem of searching and matching the right service provision to a client service requirement in a web service architecture is basically reduced to a problem of matching the service *function* and *behavior* descriptions to the service requirement specification.

In this paper, we propose a service description ontology to describe a service with a service description feature set. Table 1 below enlists features which are generally applicable to most web services. Those features can be extended to include features which describe more specific functionalities of web services such as pedagogy. The features on a feature list can either *mandatory* or *optional*. They serve to index a service for *searching*, *filtering* and *ranking* purposes.

Sub categories	***Feature set***
General	{name, description, language, owner, type (name, taxonomy, value), entityType}
Meta-metadata	{metadataCreator, metadataValidator, creationDate, validationDate, language, format}
Life-cycle	{creator, dateCreated, version, status, contributor, publisher, dateUpdated, extentOfValidity}
Right	{IP, accessRight, signature, provenance, dateCreated, dateUpdated}
Technical	{URI, resource, resourceURI, resourceFormat, replacedBy, realisation, modeOfInteraction}
ServiceRequirement	{listInput(name, type, value, ontologyURI), listOutput(name, type, value, ontologyURI), expectedEffect}
DomainContent	{listDomainConcepts}
Context	{roleModels, location(coordinate, spatialLocation, locationRelativity), physical(deliveryChannel, deliverySystem, deviceModel, tool), informaticResource(hardware, software), temporal(temporalCoverage, frequencyRequirement)}
Quality	{qualityRating, trustRating, qualityGuarantee, networkedQoS, accuracy, performance, reliability, robustness, scalability, security, availability, stability)}
Financial	{cost, currency, chargingStyle, settlementModel, settlementContract, paymentObligation, paymentInstrument}

Table 1. Service global feature set

SERVICE EXECUTION ARCHITECTURE AND MANAGEMENT

We have derived a generic ISS software architecture organized around a dedicated middleware to support Human-Computer Interaction in different modalities, including speech recognition and speech synthesis. It reuses our previous work about multi-channel and multimodal intermediations between a mobile personal user device and a collection of e-services (Chevrin, Sockeel and Derycke, 2006). However, the case of an ISS is simpler here because the number of services provided is small (specialized local functionalities), and the numbers of specific devices used in the interaction with the customer is, for a precise ISS, relatively small. We can consider that the ISS is relatively autonomous, required few connections with the information system of the shop, and can be easily described in a small ontology such as a micro-world. So dynamic discovering of its services will be easier than in most of the Ubiquitous Computing projects, e.g. Smart Homes. Our generic software architecture takes into account the modularity of the ISS (adjunction or suppression of some interactive elements, needs for adaptation to a particular retail company) and its openness to the Personal Sale Assistant (PSA). Figure 2 gives an overview of the software architecture.

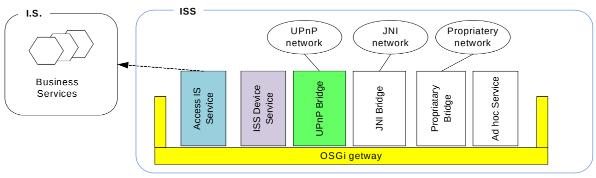

Figure 2. An overview of an ISS software

An ISS is built by assembling UPnP services (UPnP, 2007) into an OSGi (OSGi, 2007) gateway: i) UPnP is a wired IP protocol allowing the creation of spontaneous networks of devices (TV sets, HVAC, light control etc.) and control points (PDA, Smartphone, touch panels etc.). UPnP enables the live detection of devices and the use of their services by the control points; ii) OSGi framework allows deploying and redeploying Java-based plug-in applications (bundles) offering services (Donsez, 2007): a) thanks to different OSGi bridges, ISS devices can be seen as UPnP devices. The gateway allows plugging in any kind of devices as long as the OSGi driver is available. Each device company can provide drivers; OSGi and UPnP are open protocols; b) I.S. (Information System) Access Service provides the access to business objects; c) thanks to ISS Device Service, ISS can be seen as an UPnP device itself. This allows a "control point" to manage the ISS. It is what we call a "remote control device"; d) OSGi gateway can also provide ad hoc services linked with the particularities of the ISS.

ADAPTATION

The fundamental issue in a pervasive learning environment is how to provide learners with the right learning content at the right time in the right way. Thus, adaptation is mandatory to all types of learning activities in pervasive learning environments (Bomsdorf, 2005). At present, we focus on adaptation mechanisms dedicated to two categories: scenarios and (web) services. At the scenario category, adaptation is aimed at accomplishing an activity according to the current situation, or in other words how to select the relevant methods for a given task. Put differently, the learning system has to select dynamically the relevant way to achieve the different tasks included in a scenario. At the service category, adaptation is to refine the service retrieval process for a realization of an atomic task. Thus, the learning system needs to select the relevant web services according to the current situation. As context is dynamic, it is not possible to know in advance how the next situation will be structured. In other words, it is not possible to anticipate the set of features composing the different situations. For managing adaptation, it is necessary to trigger rules using the contextual features of methods and the service description of web services which are defined a priori and the set of situation features which can be unexpected – not known in advance. Consequently, it is not possible to define rules for each possible configuration of features in a situation.

Like Mobilearn European project (Lonsdale and Beale, 2004), we associate specific metadata to situation properties and/or dimensions for managing adaptation. Thus, situation features are divided into two categories: permanent and transitory. Features describing scenarios and users are available in all situations. They are permanent features in a situation. Thus, it is possible to manage them as usual because they are known a priori. Other features are transitory. For them, it is necessary to analyse how each property contributes to content adaptation – methods and services selection - differently according to its role in the adaptation process. Some of them are used to filter the content while others are used to rank or annotate it where filtering, ranking and annotation are the adaptation techniques. For instance, learning and working methods can be filtered according to learning places or used devices while it is annotated according to the user's knowledge, know-how or preferences). As soon as features are used to filter content (methods or services), it is easy to manage them. In other words, a present transitory feature may or may not filter out content. At present, all transitory features of content are used to filter. Nevertheless, we shall have to investigate this issue in depth according to more detailed scenarios in future.

Adaptation process

The adaptation process is specified for a content type (methods and services) and an adaptation category. The input content of the adaptation process can be achieved in different ways depending on the content type: input methods are specified directly by the current task while input services are selected by a search process based on a query which "compares" the service requirement of the selected task/method couple with the service description. The three stages of the adaptation process are presented as follows: i) Evaluation/Classification: input content is classified according to the current situation in several equivalence classes: two classes *{"Good", "Bad"}* for each transitory feature and up to five equivalence classes *{"VeryBad", "Bad", "ToConsider", "Good", "VeryGood"}* for all permanent situation features, together. The content belongs to an equivalent class if it satisfies its membership rules; ii) Filtering: all content belonging to "Bad" classes according to a transitory feature are filtered out. In other words, these content are discarded. For example, with the network dimension, the class *"Good"* is considered as relevant while the class *"Bad"* is not. This means that the system hence will eliminate all content that belongs to the class *"Bad"*; iii) Adaptive navigation: permanent situation features are used to evaluate and classify the remaining content. An adaptive technique can be chosen by the system or by the user according to an author decision. All content belonging to the same equivalence class are treated in the same way. Annotation and sorting are processed according to the total order of equivalence classes. For hiding, only contents belonging to the class *"Good"* and *"VeryGood"* are maintained.

CONCLUSION

We have proposed an adaptive and context-aware model of a scenario based on a hierarchical task model having the task/method paradigm - with methods defining how to achieve a task - for a pervasive learning system supporting working and learning situations. This model enables us to choose how to achieve activities according to the current situation. In other words, the relevant methods and services are selected dynamically according to the current situation for the realization of activities. We have also integrated web services described at semantic level for indexing services and an ISS architecture for executing them. Our context model and adaptation process deal with dynamic "context-as-construct" by means of transitory and permanent situation features managed in different ways. As an item for future work, we will study in greater depth our adaptation policies to manage dynamic context because at present, detail of our scenarios is limited.

ACKNOWLEDGMENT

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Mobile Learning in corporate settings[23] Results from an Expert Survey

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ABSTRACT

Against the background of the rising mobility of employees, technological innovations and the increasing importance of work based learning, a central question is whether and how mobile devices can be used to support employees' learning processes in the near future. This question was addressed to 56 international experts in a two round survey, combining Delphi and scenario-based methods. They evaluated four mobile learning scenarios, described the scenarios they expected in the immediate future and identified benefits as well as barriers and conditions of implementation. In addition the interviewed experts evaluated inherent tensions and proposed ways of addressing these.

The findings of the survey show that social interaction and reflection on learning processes received the most positive evaluation as did content-based scenarios with examples focusing on contextualised learning. The integration of learning at work was described as the most important area of inherent tension which has to be addressed. In the near future mobile learning in companies is anticipated mainly in the form of learning "just-in-case", based on human-computer interactivity.

Author Keywords

Mobile learning in companies, work based learning, contextualisation, reflection, coordination, coaching

THEORETICAL BACKGROUND AND RESEARCH QUESTION

Definition of corporate mobile learning

Although mobile learning may blur the lines between work and learning, research requires a clear definition and demarcation of the subject addressed:

Corporate mobile learning takes place *when **mobile** employees are supported in their **learning** activities with **portable** computational devices.*

An activity is defined as learning when it leads to a deeper understanding and takes place within a didactical framework. The framework is defined by the curriculum, teachers, or by the learners themselves (compare Göth et al., 2007, p. 2). Pure information retrieval which does not to lead to more in-depth knowledge or skills acquisition will not be considered as learning (Frohberg, 2007, p. 8).

Distinctive to mobile learning is the mobility of the learner, rather than the portability of the technology (Sharples et al., 2005b). Mobile learning "happens when the learner is not at a fixed, predetermined location" (O'Malley et al., 2003, p. 6). Employees may learn either while they are locally mobile (wandering), moving around within an area such as a hospital or a construction site or when they are moving between different work locations (visiting, travelling), as is the case for field staff or sales representatives (compare Kristoffersen and Ljungberg, 1999, p. 31). However, the use of portable, computational devices[24] such as Smartphones, PDAs, Tablet PCs or Notebooks for learning purposes is also a prerequisite.

Mobile learning in companies – literature review

Mobile learning has mainly been implemented and examined in schools and institutions of Higher Education. Companies seem to be more hesitant to deploy mobile technologies for learning (Härtel et al., 2007). The existing body of literature clearly reflects this finding. "Corporate mobile learning" was addressed by Pasanen (2003) in a chapter of the book "Mobile Learning". The author describes mobile learning as using the flexibility of mobile devices for the access to and the production of learning material, for learning communication and for the management of learning. He stressed the importance of an integration of mobile learning into the corporate information infrastructure and the strategic importance of mobile solutions: Mobile learning encourages innovation and offers new business opportunities. Moreover, Pasanen identifies further benefits from the different perspectives, for example, effective learning material collection (student's

[23] Including the health sector
[24] In the following shortened to "mobile devices"

viewpoint) or improved customer service (customer's viewpoint) (Pasanen, 2003). His arguments are based on a review of the literature and his own conclusions without collecting primary data.

Non-scientific contributions from the field of commercial and industrial training indicate that companies might benefit from this barely-established form of technology-enhanced learning. According – for example – to a "case study" from a bank – which distributed audio messages to employees– the feedback from the involved managers was "100% positive" (Weekes, 2008). Another large financial institution delivered compliance training courses to their employees using the Blackberry. The results included a more timely completion and a 12% higher completion rate compared to the control group within a two month testing period (Swanson, 2008).

Mobile learning has been also deployed in the ICT sector. An international telecommunications provider delivered mandatory compliance training sequences to nearly 30.000 on-the-road engineers. Another, complex engineering scenario was depicted by a French research institution (David et al., 2007, p. 3): A mobile learning platform provides engineers with the opportunity to study small contextualized and personalized learning sequences while repairing manufacturing plants. The contents are displayed via WiFi and RFID technology on see-through goggles with an integrated screen. If the engineer has a problem he can contact an expert by chat or contextualized e-mail which automatically includes machine references. The purpose of the activity, beside the plant repair, is the internalisation of important functions and repair principles. However, the scenario has not been tested in companies so far. In a third example, a huge multinational computer technology and consulting company provided small personalized information for a group of employees. The profile was based on Human Resource data and completed by the employees according to their qualifications, expertise and interests. If relevant content was available the learners were instantly notified via mail or SMS. Due to high technological requirements, only a small percentage of the employees had the capability to download the contents on their mobile devices (von Koschembahr and Sagrott, 2005, p. 165).

In an on-the-job learning project a mobile feedback and diary application was developed for apprentices who work temporarily in companies. The students answered daily questions about events and feelings on their mobile phones. In addition, they could document their experiences and enrich their feedback with pictures, videos and sound taken with a camera phone. The evaluation with 23 students concentrated mainly on the usability of the product. The impact of using the tool has not been evaluated so far (Pirttiaho et al., 2007, p. 221). Another project illustrated how learning materials can be created and shared by learners: Staff at an Intensive Care Unit videotaped how they handled technical equipment with a video camera. The sequences were provided to colleagues who viewed them on handheld mobile computers immediately on site via RFID technology. The scientific evaluation showed that these practices augmented informal peer-to-peer learning (Brandt et al., 2005). However, in spite of widespread camera phones and mushrooming online video platforms the practice of producing and sharing videos has not entered mainstream use in businesses so far.

In conclusion, no systematic research on mobile learning in companies has been conducted as yet. There are some papers on the use of mobile learning in companies. Most of them are non-scientific, without serious evaluation, conducted by internal evaluators. Consequently, they are of little scientific significance. However, they might provide ideas of upcoming mobile learning trends.

Generally speaking, corporate training is more content-oriented than based on social interaction (Kukulska-Hulme and Traxler, 2005, p. 39). It remains to be seen whether this focus will be shifted by mobile devices, whose communication capabilities have been considered amongst the most useful features in mobile learning projects (compare for example Sharples et al., 2005a).

Catalysts for mobile learning in enterprises

In 2003 – in a Delphi study on the development of mobile learning – broadband technologies and 3G portable devices were considered important and wireless Internet access was described as the „backbone of mLearning" (Dye et al., 2003, p. 49). Today mobile broadband coverage has remarkably improved and mobile technologies such as cell phones are widespread (compare for example BAKOM, 2007) and multifunctional: Smartphones are combining more and more capabilities – ranging from telecommunication and video capturing to personal information management (Livingston, 2004). At the same time costs for telecommunication have been decreasing (compare European Statistics e.g. eustatistics.gov.uk, 2006) . This is a key factor in the spread of mobile learning (Dye et al., 2003, p. 49). The Horizon Report seeks to identify emerging technologies likely to have a significant impact on teaching, learning, or creative expression within learning-focused organizations. It also emphasised the importance of mobile technologies: G*rassroot videos* and *mobile broadband* are two out of six technologies that are likely to enter mainstream use (New Media Consortium and EDUCAUSE, 2008, p. 3). Both are closely related to mobile learning.

Mobile employees with poor access to stationary IT infrastructure are also considered as important drivers for mobile learning in companies: Nowadays jobs are decreasingly performed at fixed locations, project teams are formed temporarily (Bergmann, 1999, p. 14) and, consequently, the number of mobile employees is on the rise (Lesser, 2005, p. 3). If mobile workers are supported with mobile devices, the existing technology is likely to be used for learning purposes as shown in the health sector: When analysing the use of PDAs in medical and nursing professions, Luanrattana et al. (2007) reported that PDAs are widely used for work routines and increasingly for educational purposes. In a more general analysis on the potential of mobile learning in the health sector the author claimed that: “Mobile learning is being embraced because mobile computing is being embraced in this sector” (Burger, 2006).

The corporate learning landscape is also changing: Work-based and informal learning are gaining in importance (Lundin and Magnusson, 2003, Hardwig, 2006, p. 191). Recent empirical studies show that the majority of professional competences and skills are acquired through informal learning (compare for example Dehnbostel, 2006, p. 165, Livingstone and Scholtz, 2006, p. 45) such as self-directed efforts or the mentoring of more experienced co-workers. Only few employees regard formal training courses as the most important source of job-specific knowledge (Livingstone and Scholtz, 2006, p. 45).

It is claimed that skills such as problem-solving abilities and autonomy cannot be adequately taught from the outside. They have to be developed by self-direction in appropriate learning conditions (Hardwig, 2006, p. 191). Employees should not learn *“just-in-case”*, but in their work setting, through ongoing changes in their companies (Loroff et al., 2006, p. 7). The main route of learning is to be found by engaging in tasks (Bergmann, 1999, p. 108). “*Learning can no longer be dichotomised into a place and a time to acquire knowledge (school) and a place and a time to apply knowledge (the workplace)”* (Fisher, 2000). It is therefore becoming increasingly difficult and ineffective to train employees only in a classroom setting (Hardwig, 2006, p. 7, Loroff et al., 2006, p. 9). However, classroom training should not be played off against other forms of learning. Combined, they can lead to new ways of learning (Hardwig, 2006, p. 199) with the potential to improve the learning transfer from traditional classroom training into work routines (Bigalk, 2006, p. 184).

Mobile learning could also address these demands of the changing corporate learning landscape: Employees can access information autonomously in informal settings without access to stationary IT-infrastructure. Mobile devices might encourage work process oriented learning: It is theoretically possible to bring training and practice together and “to access theory and knowledge in the context in which it is to be applied - in the work process” (Attwell, 2007, p. 3). Due to a focus on “efficiency gains and cost savings in short timescales” (Kukulska-Hulme and Traxler, 2005, p. 39), some companies might try to enhance productivity through “just-in-time” learning with mobile devices (compare von Koschembahr and Sagrott, 2005, p. 165). Learning sequences can be accessed exactly when needed (Kukulska-Hulme and Traxler, 2005, p. 39). Sharing images and videos to solve immediate problems might lead to improved mentoring. Mobile devices could also encourage learning processes and reflection, as was the aim of an on-the-job learning project (Pirttiaho et al., 2007, p. 218 ff). In addition, they may aim to improve the learning transfer from face-to-face training into work routines, as in the case of a project carried out by an international airline (Lison, 2004).

Guiding question

Against the background of the increasing mobility of employees, technological innovations and a changing learning landscape, the central question is whether and how mobile devices can be used to support employees’ learning processes in the near future.

RESEARCH METHOD

Due to the limited number of corporate mobile learning applications and the dearth of scientific literature on the subject, the authors have primarily used an explorative research strategy. The study was conducted as an expert survey consisting of two rounds. The research design combined Delphi and scenario-based methods. The Delphi method is particularly well suited to new research areas and exploratory studies (Okoli and Pawlowski, 2004, p. 15). It can be characterized as a tool for highly structured group discussions to create solutions for complex problems (Bortz and Döring, 2002, p. 261) and to obtain a reliable consensus among a group of experts. Delphi methods have not only proven to be a popular tool in the general field of research on information systems (Okoli and Pawlowski, 2004) but have been also used in the field of mobile and work-based learning or for the evaluation of evolving learning technologies (compare Dye et al., 2003, Pehkonen and Turunen, 2004, New Media Consortium and EDUCAUSE, 2008). Finally, the Delphi method does not require the experts to meet physically. This would have been impossible for such a huge number of international participants from various fields.

The experts evaluated short, manifold scenarios that might be broadly implemented in the future. Scenarios typically illustrate significant user activities and support reasoning about situations of use (Carroll, 2000, p. 42). The rough scenario descriptions comprised the target group (*who is learning?*), the framework (*in which business context does the learning take place?*), learning methods and social forms (*how the participants learn*) as well as technology (*which mobile and network technologies are used?*). The scenarios should illustrate manifold applications and, therefore, do justice to the variety of mobile learning forms.

Due to the complexity and interpretative scope of the rough scenario descriptions the goal is much better achieved by qualitative data collection techniques. Quantitative methods have primarily been used to triangulate qualitative results. Through this triangulation more credible and dependable information should have been achieved (compare Decrop, 1999, p. 157).

The international group of study participants consisted of 56 experts in the first round: academics in the disciplines of pedagogy, psychology and information technology and managers in charge of in-company training and mobile and e-learning vendors. 39 of them participated in the second round[25]. As differences between University education and corporate training should not be overstated (Kukulska-Hulme and Traxler, 2005, p. 39) experiences in the field of mobile learning can be extrapolated – with care – to business contexts. Therefore the involvement of academic scientists with experience in mobile learning was considered to be very important. A majority of the interviewed persons were from German and English speaking regions. The research design and results of the surveys were discussed in a sounding board, consisting of experienced scientists and managers in charge of in-company training. Pre-tests served to validate the instruments of data collection.

In the first round the participants evaluated the potential benefits of four mobile learning scenarios. They made quantitative evaluations of potential benefits on a five point Likert scale (ranging from very high benefit to no benefit at all). They were asked to give reasons for their choices. They also described potential future forms of mobile learning in companies and their benefits as well as barriers and conditions. In the second round they were asked to re-evaluate the potential of the four scenarios, taking into consideration contradictory arguments from the first round. In addition, the importance of the mastery of various inherent tensions was evaluated on a four point Likert scale (ranging from very high relevance to no relevance) and approaches to solutions to these tensions were identified.

Limitations

The generalisation of the results corresponding to individual scenarios has to be made with caution, due to the interpretative scope of the given examples. However, the goal of this research was a rich discussion of manifold scenarios and influencing factors in order indicate the direction of mobile learning in companies.

RESULTS

Evaluation results of the four scenarios

Qualitative results

i. The first scenario describes a sales representative who learns with personalised learning objects on his mobile device in quiet moments. The study participants positively highlighted [26] the flexibility in terms of time and space and the personalised, self-directed approach. At the same time they questioned the use of quiet moments for learning purposes. These moments would be frequently used to fulfil working tasks, to relax or to reflect. Critical to success is the learning atmosphere, which should be free of distractions and noise.

ii. In a further example – where engineers access learning materials on display goggles during repair activities – the situational and problem-based approach was seen as positive. Criticism referred mainly to the difficulty in implementing this scenario caused by the automatic contextualisation of learning materials. An increased error probability through learning while working will also affect the scenario negatively. Lack of time for reflection at work should be compensated by additional phases of reflection after finishing the repair process. This may lead to better internalisation of acquired competences.

iii. When nurses document how they handle important work tasks in short video clips, learning and reflection processes are already taking place during the production phase. These videos can be accessed context-sensitively on site by other colleagues on their PDAs. The interviewees criticised that nurses rarely have quiet moments to produce and consume the videos. The experts also questioned whether the nurses had the necessary didactic and technical skills to produce learning materials of high enough quality.

iv. In the fourth scenario apprentices in companies answer daily questions from their classroom teacher to reflect on their learning progress and document their learning experiences in an electronic learning diary. They are said to have a particular affinity to mobile phones. The interviewees commented on the consistency of the learning processes through daily incentives. This should positively stimulate motivation and acceptance. Learning transfer between school and work-based learning was considered as beneficial. The huge effort required by teachers and the high level of self-discipline of apprentices may affect the scenario adversely. In order to realise the scenario successfully, many participants recommend the pedagogical use of the feedback in the next classroom training session.

Quantitative results

The scenarios were evaluated similarly as having between *some benefit* and *high benefit* (with arithmetical means between 3.2 and 3.8 on a five point Likert scale[27]). The discussion, however, was controversial: While the scenarios

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[25] Participants/professional background:

	Academics	Managers	Vendors	Not stated	Total
1st round	28	23	5	-	56
2nd round	17	17	3	2	39

[26] All the arguments of this chapter were named at least seven times in the two rounds

[27] numerical values: 1=No benefit at all, 2= Little benefit, 3= Some benefit, 4= High benefit 5= Very high benefit

based on human-computer interactivity (*engineer* and *sales representative)* were judged more similarly in the second round[28], the variation in the scenarios with social interaction (*nurse and apprentice*) remained equally high[29].

For three of the scenarios, changes from the first to the second round were not significant. Only the *apprentice scenario* was evaluated significantly more highly in the second round[30]: As shown in the matrix below, 13 persons increased their rating, whereas only 9 experts reduced their rating. Overall, this scenario was rated most highly in the second round. However, there was some disagreement in the evaluation of the scenario, as shown in Table 1. The boxes marked in grey highlight the changes in opinion that contributed to a relatively high standard deviation.

2nd round / 1st round	☺☺	☺	😐	☹	☹☹
☺☺	1	2	1		
☺	1	9	3		
😐	1	8	2	2	1
☹		1	1	1	
☹☹	1				

Table 1. Evaluation of potential benefits between the first and second round.

Considering the means of both rounds, the potential benefit of the scenario *engineer* was – in comparison to the other scenarios – rated most highly[31]. However, also the requirements for realising this scenario were – with little deviation – rated most highly compared to the other scenarios[32]. This reflects the qualitative evaluation results.

A framework for classifying mobile learning scenarios

The question describing future scenarios – considering target group(s), learning framework and methods, social forms and technology – has led to a comprehensive range of more than 30 examples in various thematic and working contexts. These are classified in the framework below according to their value to work process and their media function (compare also Gröhbiel and Pimmer, 2008).

		Learning based on	
		Human-computer interactivity	Social interaction
Learning has	Immediate value to work process: "just-in-time"	**Individual «just-in-time» learning**	**Interpersonal «just-in-time» learning**
	Potential value to work process: "just-in-case"	**Individual «just-in-case» learning**	**Interpersonal«just-in-case» learning**

Figure 1. A framework for classifying corporate mobile learning scenarios

The framework helps to make the distinction between different degrees of integration of learning in the work process on the one hand and between human-computer interactivity and social interaction on the other hand:

Vertical axis:

Just-in-time learning has an **immediate value to work process.** It comprehends the acquisition of knowledge and skills on-the-job due to immediacy and relevance (Harris et al., 2001, p. 276). Just-in-time learning is job-embedded and, therefore, might consist of learning by doing, reflecting on the experience, and generating and sharing new insights and learning with others (compare Wood and McQuarrie, 1999).

Just-in-case learning has a **potential value to work process**. It is learning for potential future application (compare Harris et al., 2001, p. 276). The emphasis is on knowledge and skills that might be useful later. It is hardly possible to predict whether and when it will be needed (Kirsh, 2000, p. 30).

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28 Standard deviaton of 0.6
29 Standard deviaton of 0.9
30 T-Test, n=35, arithmetical means in 1st /2nd rnd: 3.46/3.66 standard deviation: 1/2 rnd: .919/.906, statistical significance at test with paired samples: .324, numerical values: 1=No benefit at all, 2= Little benefit, 3= Some benefit, 4= High benefit 5= Very high benefit
31 arithmetical means in 1st /2nd rnd: 3.84/3.59
32 Numerical values: 1= Very low, 2= Low, 3= Medium, 4= High 5= Very high. Arithmetical mean of scenario engineer: 4.47; The other scenarios were all evaluated similarly as having between medium and high requirements (3.2-3.5).

Horizontal axis:

Individual learning is primarily based on **Human-Computer Interactivity**. It describes the possible courses of action of the individual learner with a learning object (Schulmeister, 2004, p. 12). Feedback is given implicitly or explicitly by the learning object or by the (electronic) learning environment (Schulmeister, 2004, p. 15) in dependence on the learner's previous actions.

Interpersonal learning refers to the **social interaction**s between humans. It comprises collaborative learning, tutoring, teaching or coaching mediated by portable computational devices; consequently, feedback is provided primarily by peers, mentors, teachers etc.

Both the degree of interactivity and the social interaction are considered by many authors as very important for the success of virtual learning (Schulmeister, 2004, p. 12). The following figure illustrates the classification of beneficial scenarios expected by the experts in the next 2-5 years. The size of the boxes represents the approximate number of scenarios:

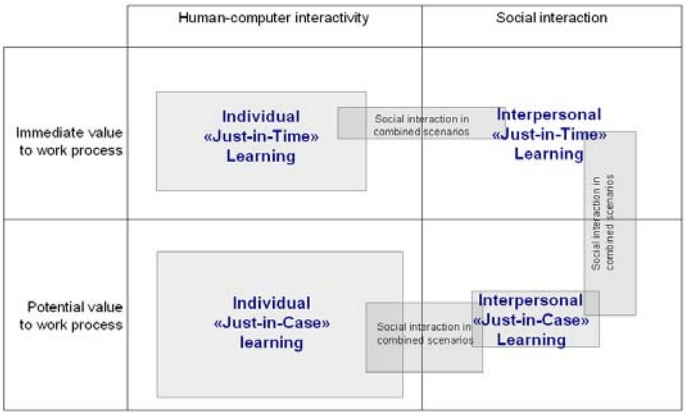

Figure 2. Expected mobile learning scenarios in companies in the near future

1. Scenarios situated solely in the area of just-in-case learning were described considerably more often than scenarios based on learning while working: It was primarily examples based on human-computer interactivity that were depicted in this field. This currently prevailing form of mobile learning (compare Frohberg, 2006) is also expected to predominate the corporate landscape in the near future: Examples were described where employees such as investment brokers or bank employees learn in advance and apply their knowledge in later phases: They are texted as soon as new materials are available, work on small learning items and then check their knowledge with quizzes.
2. In the area of just-in-time learning, most of the examples were described in the field of human-computer interactivity. Scenarios based on social interaction were cited only in combination with scenarios from other quadrants as illustrated by the following example: If mechanics, medics or builders who are working on a certain task for the first time face a problem they can't solve on their own, they can contact an expert with their mobile devices. Details of the objects are captured with the integrated camera. The expert explains the procedure while annotating the image. The indications are synchronously visible on the screen of the learner's device. If the session is recorded and available to other learners in similar situations, the scenario is expanded to the field of human-computer interactivity.

Beyond the documentation of coaching processes – as described in the example above – the production and sharing of further learning sequences such as incidents, unusual situations or the usage of products by customers were described several times.

Dealing with inherent tensions

When analysing answers related to benefits several areas of tension have been identified. A majority of the respondents attributed high or very high relevance to the mastery of the following four inherent tensions:

1. It is clear that the integration of learning at work is beneficial; at the same time learning and work processes may interfere with each other.
2. Although technical affinity to mobile devices is high for some (groups of) employees, prerequisites for learning such as motivation and self-discipline are sometimes insufficient.
3. Continuous innovation of mobile technologies will lead to noteworthy improvements. However, in the immediate future the technical requirements for the successful implementation of some mobile learning scenarios will not be met.
4. While the production of learning materials by employees creates additional benefits, privacy issues and poor technical or didactical skills of employees may limit this potential considerably.

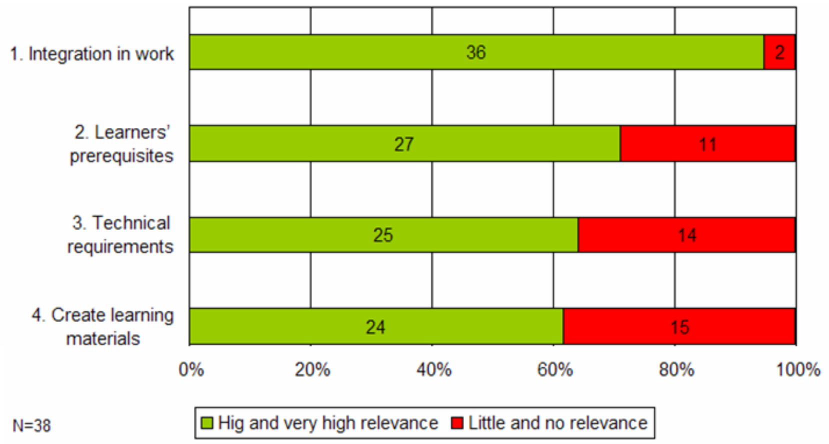

Figure 3. Importance of areas of tension to be reconciled

In order to overcome these inherent tensions the experts made the following suggestions:

To foster the integration of learning processes at work employees should have time that is explicitly designated for learning. The time used for learning should of course not be paid for by the customer. Mobile technologies should only be deployed if they provide an advantage over other technologies. If possible, employees should learn with devices they are already using for work. Quiet moments, if these exist at all, are rarely appropriate for learning.

Certain prerequisites are critical success factors for mobile learning. The interviewed persons proposed enhancing the learners' motivation by means of concrete incentives (for example, the implementation of ePortfolios) or by making mobile learning a requirement. The advantages of the application should be clearly demonstrated to the learner. Approaches related to the peer-to-peer production of learning material require training courses and quality control conducted by teachers. Learners should be able to delete their contents any time.

CONCLUSIONS AND FURTHER DISCUSSION

The findings of the expert survey indicate that the following development options deserve closer attention:

1. Just-in-case learning based on **human-computer interactivity** was described by most of the experts as the prevailing form in the immediate future. While having moderate **benefits,** the implementation of this kind of scenario seems to be relatively **easy**. The use of "quiet moments" for learning does not seem to be appropriate. The personalisation of learning contents and the learning atmosphere were considered as very important to success.
2. The **contextualisation** of learning and the **integration in work** processes is very promising. Nearly all experts pointed out the high relevance of this area, which is at the same time **challenging**: Technical and organisational challenges have to be tackled and learners should be given additional time for reflection.
3. Beyond human-computer based learning forms, scenarios focusing on **social interaction** also provide high potential benefits. Mobile devices can support **coordination, coaching** and **collaboration**. Trainers can send messages to **coordinate** learners' activities and to encourage learning and **reflection** processes. This can enhance the continuity of the learning process and increase the motivation of the learner as indicated in the apprentice scenario. With low requirements and predominantly positive feedback it is worthwhile to consider how this scenario can be applied to other fields.
   Integrated tele**communication** and **collaboration** features can make synchronous annotation of pictures possible. This is a capability which could ideally be used for **coaching**. In this way problems can be discussed and reflected on among learners and tutors.
4. Reservations were expressed in the evaluation of the **production and sharing of learning material**s. There are demands on learners in terms of the mastery of technical and didactical skills in order to produce learning materials of high enough quality. The learning and reflection processes taking place during the production were very positively highlighted. Particularly in the context of the increasingly popular Web 2.0 applications these kinds of scenarios should be kept in mind.

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The Nintendo DS as an Assistive Technology Tool for Health and Social Care Students

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ABSTRACT

This paper describes the evaluation of a two phase TechDis Higher Education Assistive Technology (HEAT) project. The project investigated the use of the Nintendo DS Lite mobile gaming device alongside Brain Training, Big Brain Academy and Opera Browser software packages as assistive technology tools for health and social care students. It presents key findings concerning the use of a mobile gaming device within a Higher Education (HE) environment. The paper also aims to raise awareness of some of the educational possibilities for students and staff, including improving numeracy skills and providing mobile web access.

Author Keywords
mobile learning, m-learning, numeracy, Nintendo DS Lite, brain training

BACKGROUND

The potential benefits of playing games to help improve educational performance have become an interesting area for investigation and debate. A 2006 study by the Federation of American Scientists (Nintendo, 2006 A) claimed games could teach skills including strategic thinking, interpretive analysis, problem solving, forming and executing plans and adapting to rapid change. October 2006 saw the launch of a report examining the role computer games could play in education (ELSPA, 2006). Introducing the report, Lord Puttnam said:

> *Increasingly video games are being recognised as a powerful tool for learning. Yes of course they are entertaining and a lot of fun, but they've also the ability to inspire and motivate. They hold out the tantalising prospect of personalised, responsive and thoroughly enjoyable learning experiences, irrespective of age, or our ability.*

The debate has also encompassed whether handheld gaming devices could be used successfully as educational aids with Heppell (ELSPA, 2006) noting young student requirements:

> *If wireless collaboration and fun is so easily carried in their pockets and so much a part of their computer gaming world then, they might not unreasonably ask, where is it in the classroom?*

The Nintendo DS Lite handheld gaming system was launched in Europe in 2006. The system combines dual screen viewing with interaction provided by a combination of the innovative touch screen and stylus - alongside traditional controls. The device also includes wireless technology and software allowing users to send messages and drawings to each other (PictoChat). This lighter second generation console – replacing the original Nintendo DS - has become Europe's best-selling games console, with over 14 million sold to date and in many markets across Europe it is the fastest selling handheld games console in history (Nintendo, 2007). Potential educational uses for handheld gaming devices like the DS Lite are becoming increasingly popular with the possibility of access to software for educational improvement encompassing many disciplines.

Rice (2007) noted that Nintendo had been expanding the market for Game Boy Advance (GBA) applications – prior to the launch of the DS - adding applications for reference manuals and tutoring software. Since the launch of the DS, he noted educational and reference titles that appealed to adults and had more serious uses were starting to become more popular in Japan, as at a low price point, integration into the classroom seemed economically viable. Additionally the innovative features of the DS intrigued Japanese educators, who began to think of educational applications. Kane (2007) cites one early idea was use of the DS as an electronic English tutor. After a trial with English tutorial software; the pilot school found nearly 80% of students who used the DS each day mastered junior-high-level competence in English vocabulary, compared with 18% before. Rice (2007) concluded this was consistent with research on appropriating the GBA for educational purposes where Lee et al. (2004) were able to show a higher rate of practice math problem completion with students using a GBA math game than those in the control group using traditional worksheets. More recently, in Dundee, a class took part in a project using Dr Kawashima's More Brain Training on the DS (BBC, 2008). Progress was compared to another class where similarly aged pupils used Brain Gym - a series of body exercises designed to increase brain activity and enhance learning - and a control group with no access to either alternative. After taking the same maths test at the project start and end, all groups had better scores after 10 weeks with the biggest improvement in the Kawashima group. In addition to a noticeable impact on behaviour and levels of concentration, Robertson (BBC, 2008) was struck by the dramatic enhancement in the Kawashima group's maths ability:

> *The results of this small-scale Dr Kawashima project have shown how a targeted and managed use of such a game can help to enhance pupil numeracy skills and classroom behaviour.*

Dr Kawashima's Brain Training – the predecessor to More Brain Training - challenges players to spend ten to fifteen minutes each session performing arithmetic, word memory and concentration tasks using the touch screen to write, draw or select options. The game was initially released to the Japanese market in 2005 where it went on to sell over 2.3 million copies (ELSPA, 2006), whilst the European release of Brain Training in 2006 and More Brain Training in 2007 were marketed as part of Nintendo's Touch! Generations campaign. This range is a collection of software titles offering a variety of unique ways to play. Another title in the range, launched outside of the UK in October 2006, offered an English training package with the press release stating it was perfect for anyone who hadn't the time, money or self-confidence to go on a course (Gamespot, 2006).

THEORY

Dr. Kawashima is a leading figure concerning Brain Imaging Research, the investigation into functions of each area of the brain. In a 2001 study (McVeigh, 2001) he found computer games only stimulated activity in the parts of the brain associated with vision and movement. He analysed brain activity in children playing Nintendo games and engaging in an arithmetic exercise where numbers were added continuously for thirty minutes. His findings indicated that in contrast to games, math exercises stimulated brain activity in the left and right hemispheres of the frontal lobe - the area most linked with learning, memory, emotion, and behaviour control. In 2004, Dr. Kawashima's book, 'Train Your Brain: 60 Days to a Better Brain', became a bestseller. The principles of the book were later developed into the DS game Dr. Kawashima's Brain Training: During later research, in which he captured the activity of the brain in photographic images, Dr Kawashima focused on the relationship between the brain and body (Nintendo, 2006 B) and came to believe that people should train their brains:

> *When we use our brain every day in a routine manner, this may not be enough to challenge it. Therefore we should consciously challenge our brain to do different things for about 5 - 10 minutes every day at least. We have learnt from our experiments that the brain can be trained in this way. Just as you can challenge and train your body, so can you challenge, train and stimulate your brain.*

Dr Kawashima identified several principles (Nintendo, 2006 B) involved in training the brain. By combining these into everyday life in a challenging and creative way, he believed the sharpness of the brain could be maintained:

> *Thinking, creating something new, effective communication with other people, high aspirations, and concentration - we know that all these functions are influenced by the prefrontal cortex. It is also thought to be a place for processing and integrating information, such as the proper evaluation of information in accordance with the context and the initiating of an activity. It is also very influential in coordinating the control of our emotions and actions.*

Curland and Fawcett (2001) identified research carried out into the perceived difficulties that existed amongst many school-leavers in relation to numeracy skills. In the 1990s, Treffers (1991) related the problem area back to primary school level and Eisenberg (1991) looked at building self-confidence in mathematics. Further research focused on the lack of numeracy skills carried forward by school-leavers into the workplace and into higher education with Cornelius (1991) reporting that very often fear of numbers could be a major barrier to learning. From a medical perspective, students need to have the ability to quickly calculate measures on drugs rounds and in other areas of their role. Students entering health and social care with poor numeracy skill levels have also previously been flagged as an area of concern by both academics at the School of Health & Social Care (HSC) and also reflected in research (Gillham and Chu, 1995). Any tool that may help to improve skill levels is therefore viewed as extremely beneficial.

METHOD

For phase one of the project (September 2006 – December 2006), four Nintendo DS Lite's and four copies of Brain Training were acquired from the TechDis Higher Education Assistive Technology (HEAT) scheme. Twelve students signed up for the project from a range of health and social care courses. After a one hour induction session, participants were able to choose to do as many sessions as required for the project duration. Each session could consist of a personally chosen selection from the different training options available on Brain Training. At the end of the project, all participants were asked to complete a questionnaire concerning their use of the DS and Brain Training software. In total, 54 individual sessions were completed, but students did not have the full flexibility to take the package with them. As one copy of the software held four different student records if the kit was taken off-campus and another student wanted to use it at the same time they would have to wait until it was brought back. Secondly, a large percentage of students were involved in long periods away on placement during the project which caused scheduling difficulties. These issues could only be resolved by asking participants to come to a central campus location to use the package. This meant other satellite sites - such as Yeovil and Portsmouth - were unable to take part in phase one of the project.

For phase two (October 2007 to March 2008), additional hardware and software was acquired from the TechDis HEAT 2 Scheme for further investigation. Big Brain Academy is another release from the Touch! Generations series providing fifteen mini games testing the ability to think, analyse, compute, memorise and identify. Opera Browser is based on the same core as the Opera desktop browser, delivering high speed web page rendering. Users have the ability to connect to the Internet with their DS via a hotspot or wireless router, navigating the web with PDA-like functionality. Browser functionality could potentially be used inside classrooms and seminars or outside campus on any valid wireless network. Although the browser supports a range of formats, file types not supported include Flash, movie, sound and PDF files whilst files requiring a plug-in – such as Microsoft Word or Excel - could also not be viewed. During phase two, three students were given a DS Lite and copies of Opera Browser, Brain Training and in two cases Big Brain Academy for a sustained time period. This allowed more flexibility in assessing how the DS could function as an educational tool. For example, when phase one participants were asked if given the opportunity they could access the Internet through a DS would they make use of it in a classroom or home environment, 65% said they would. At the end of the phase two, the participants were asked to complete a questionnaire concerning their use of the DS and software packages in addition to providing a short report on their individual usage over the project.

When questioned, the majority of students taking part in the two project phases wanted to improve their numeracy skills for areas including drug calculations, fluid and balance charts and weight measurement. Fifty percent of the participants had attained a Math Level equivalent to Key Skills 2 whilst the other fifty percent had attained a higher-level qualification. A third of participants had particular additional learning needs over and above wishing to improve numeracy skills - these included Dyslexia, Dyspraxia, Dysnumeracy, Dyscalculia and visual processing problems.

CONTRIBUTION

A literature review examining the use of mobile gaming devices within Higher Education (HE) reveals there is currently little research available as most interest tends to focus on secondary and primary school education. This project hoped to build on the existing work undertaken by Traxler (2006) and Evans (2006) in the emerging area of m-learning within an HE environment. The twin goals of the project were to investigate the use of software packages like Brain Training, Big Brain Academy and Opera Browser as assistive technology tools for health and social care students and secondly to provide an overview of using a mobile device – the Nintendo DS Lite - within an HE environment.

Of key interest to the HEAT project and HSC were the outcomes in terms of the inclusion benefits to the specific students involved, the wider discipline and the transferability of the methodology to other disciplines. For example, could the use of Brain Training software - as an aid to providing support and confidence for students with poor numeracy skills - make a positive difference to the student learning experience? In the two project phases, the technology would be utilised to find out how successful it was in reflecting some of the perceived benefits for student learning:

- Automatic recording of results and the ability to measure performance over a period of time providing an incentive to compete and compare performance.
- Privacy of using a handheld system removing some of the stigma attached to students having difficulty with numeracy and feeling reluctant to approach someone.
- A fun and engaging way to learn - simple and accessible to use and interact with.
- Available to use 24-7 with wireless internet access provided by the Opera Browser.

EVALUATION

Nintendo DS Lite (Hardware) – Positive Reponses

When describing what they enjoyed about using the DS Lite, students noted the following:

- Design - small and light, easily portable, compact in design and a clearly visible touch screen.
- Sociability - participating in a group together helped to forge friendships.
- Usability - very easy to use for novices.
- Wow Factor - the fact that the DS was perceived as ‘hip’ allowed some mature students to discuss what they were doing with their children.

When asked if given the opportunity they could access the Internet through a DS would they make use of it in a classroom or home environment, positive responses included:

I would make use of it both in the classroom and at home. I would take it with me like a PDA.

I would make use of all available resources both at home and in study. The advantage is that the DS is compact and light.

Participants were asked to express their thoughts regarding their attitude toward the DS:

- All students agreed that the mobile learning experience was fun (83% strongly agreed and 17% agreed)
- All students would recommend this method of study to others (75% strongly agreed and 25% agreed)
- All students thought that using this method of training did not hinder their learning (92% strongly agreed and 8% agreed)
- All students felt comfortable using the DS because they knew how to use it (75% strongly agreed and 25% agreed)
- All felt that they could see the screen well, hear it ok, and could easily use the equipment (75% strongly agreed and 25% agreed)
- Most importantly, all valued the experience of using the device (83% strongly agreed and 17% agreed).

When comparing the DS to other methods of learning participants noted:

I think a balance of learning styles should be accommodated and the DS would fit nicely alongside the more traditional learning methods.

I do not 'learn' by reading, so actually doing something physically helps me to take information in.

The DS is far more convenient and more enjoyable, in fact you don't realise that you are learning.

Nintendo DS Lite (Hardware) – Negative Responses

In phase one, participants were asked whether it was a problem attending university for sessions and whether they would have preferred to borrow the DS. Although some found attending enjoyable and a social occasion when groups of students occasionally came together, most agreed it would have been far more convenient to take it with them, enabling practice whenever they had spare time:

Very difficult as lesson times changed a lot and then was out on placement, it would have been much better to have used it at home.

I would have preferred to borrow the package as I would have spent a lot more time using it.

Brain Training (Software) - Positive Responses

When describing what they enjoyed about using the Brain Training package, students noted the following:

- Usability - easy to use with clear instructions and colourful. The tasks were easily understood and deemed suitable for any age group:

  I was sceptical of the DS as a learning tool to begin with; having never enjoyed video games before, being dyspraxic always hindered my coordination to the point of giving up. The brain training software was a totally different set up, by allowing me to see visually my learning styles and achievements. It started slowly but I got better more or less at the same rate until it really took off.

- Measurement - the challenge of trying to improve on previous scores and the ability to discuss results with others was positively received. Several participants remarked on the positive aspects of seeing a visual representation of their improvement via performance graphs, and the enjoyment of the challenge of testing themselves against the machine and other students, trying to improve their scores:

  My preferred method of study is through books and well-structured lessons. I find that internet based learning extremely difficult. The DS is more interactive and challenging than that of the Pearson Package that we have to learn as you get a progress report with the DS.

- Complexity - the tasks set were deemed suitably challenging but not overly so.
- Fun to use - felt more like a game than a learning method:

  It's fun and if one knows the basics of maths then a tutor isn't required, so I would rate this quite high for people who are wanting to improve their skills who perhaps wouldn't initially go and seek help.

- Flexible – the ability to take as little or as much time as could be fitted into one session appealed.

- Variety - the different games and tasks on offer each time users returned to Brain Training was highlighted.
- Timing - the exercise lengths were relatively short enabling students to concentrate fully on the task.
- Encouraging - the occasional motivations from the cartoon host which appeared on screen were appreciated.

Students were also asked to express their thoughts regarding certain attitudes toward the Brain Training package:

- All students felt that Brain Training supported them and that the content was relevant and interesting (50% strongly agreed and 50% agreed)
- All students felt that using the Brain Training package engaged and motivated them (75% strongly agreed and 25% agreed)

Most importantly, as a result of using Brain Training, in the opinion of the students, it had made a positive difference in helping them to improve their numeracy skills:

It has helped me to gain confidence in my numeracy.

I do consider that by using this software that it has improved my memory and numeracy skills.

I feel as though answers to equations are far easier to recall, almost like beginning back at school when a teacher would test you verbally and you were expected to know the answer immediately.

I found that at first there was noticeable improvement with the results in the calculation activities on brain training, and I felt that this improvement was evident with the calculations I do in my day to day activities.

One further area of interest highlighted by one of the students in phase two was the use of Brain Training on their placement within an Acquired Brain injury unit (AQB). Participants included seven clients with a range of AQB injuries, with varying damage to brain regions. All members of the group displayed problems with cognitive functions such as memory, word/picture association, and executive functioning disorder (concentration, attention span). The group was on average thirty to forty years of age and two to seven years post-injury. The clients were receiving other cognitive training, in the form of memory groups, but the trials using Brain Training were on days when the clients had no cognitive groups and the results were recorded on those days. During the trials a memory game was taken before the clients used the software and then after a period of use for approximately twenty minutes. The clients all showed improved scores in the memory games after using Brain Training and the client's scores were progressive throughout the trials (unfortunately due to logistics, combining the results with the cognitive training group was not possible in the short period of evaluation).

Brain Training (Software) - Negative Responses

The effectiveness of the voice recognition used in tests varied depending upon the individual. The instructions stress that young women and children may find it difficult for their voices to be recognised perfectly. Some female participants experienced this problem with recognition improving if they spoke a little more deeply than usual. Even though Brain Training allows you to select a writing hand - left handed players are able to turn the DS upside down to have the touch screen on their left hand side - the effectiveness of the handwriting recognition varied according to styles of writing. These issues caused problems when correct answers were perceived differently and certain letters and words were not recognised. This resulted in frustration when better scores could have been recorded if the package had recognised the right answer immediately:

Occasionally it would misread what I had written resulting in an 'incorrect' message - this threw me and slowed my reactions down.

The system did not always recognise the number which had been written and also the occasional spoken word. This was frustrating especially if you had got the sum correct and were hence marked down.

Opera Browser (Software) – Positive Responses

Positive responses to using the wireless system outside of the university network in phase two highlighted some advantages of the Opera Browser:

I was able to connect to my home's wireless very easily, and as long as you have the WEP key to hand it is easy to set up. I was also able to use it in a few public places that had wireless connectivity and I took the Nintendo on holiday with me and was able to connect to the hotel's wireless internet which was really useful and better than taking a whole laptop on holiday. For these places it was quite useful to use it as you could check your emails and search things quickly without having to turn your computer on or carry a laptop around with you.

Opera Browser (Software) – Negative Responses

Negative reponses to using the Opera Browser included difficulties in connecting to the university network:

When I was trying to sort out the university's connection using advanced settings I found this really difficult to understand and the guide didn't talk about connecting to institution settings, which I believed was the problem.

Other negative comments around using the browser focused on the size of the screen feeling that in comparison, the computer screen is larger and therefore easier to read:

> *I prefer a bigger screen for long-term activities such as time spent on the Internet.*
> *The Internet I did use but being a smaller screen I found less useful.*

There was also a problem with actually using the browser - it was not felt to be as intuitive or easy to use as a traditional computer browser:

> *I found the browser a little hard to use sometimes too.*

During phase two, one participant was able to articulate the issues succinctly:

> *I wouldn't have had many reasons to use it during lectures, and it is quite distracting to use as people do tend to watch you using it. Also there are plenty of computers around university to go to if you need to check your email and is easier and quicker to use for emailing (i.e. typing), and as you can't use words documents etc. you are quite limited as to what you can do on it for university work purposes.*

CONCLUSION

Evans (2006) identified some specific features of mobile devices which could add benefits to the learning experience. Based on this project the following areas seem particularly relevant to use of the DS Lite:

- Support for learning styles: the features offered can support learners with preferences for textual, audio or visual presentation of different material.
- Immersive: the richness and diversity of content immerse the student in the experience. The ability to improve on previous performances and track progress is a great motivator to continue using the package. Learning in this environment offers huge potential for creating deeper learning experiences when compared to traditional methods of teaching (Biggs, 2003).
- Privacy: being able to learn unobtrusively.
- User control: students have more control over where and when they choose to study, with the possibility to take the device to use at opportune times. This assumes there are enough devices and packages to allow them to be taken outside of the campus.

In terms of the software packages tested, it can be recommended that utilising a similar methodology, Brain Training (and to a lesser extent Big Brain Academy) offer innovative approaches in helping to address numeracy skills with health and social care students. For all students – including those with alternative learning needs - it provided a positive experience for including, motivating and assisting them. This project could be simply transferred into any subject area where students are required to use and improve numeracy or potentially language skills. For example, the recent release of Maths Training (Nintendo, 2008) – involving a teaching method used across Japan to help students learn fundamental arithmetic calculations - could have similar beneficial performances for numeracy support across any university subject area where these skills needed to be improved. Alternatively, it would be a quick and easy solution to use the Touch Generations! English training package (Gamespot, 2006) and offer it as a study support aid to international students requiring language tuition. The Opera Browser is less successful as a wireless internet resource with the limitations of supported file formats and the vagaries of the current campus wireless network in comparison to external networks seemingly precluding effective use for a health and social care student on campus.

Other problems concern how devices and packages can be successfully utilised so that the maximum number of interested students can use them, in environments where students are sited at different campuses and are regularly out on placement. At present, the only way to appreciate the full flexibility of the system and software is to acquire additional units. This point raises issues of procurement, maintenance and ownership (Traxler, 2006), which need addressing.

This project falls under the banner of 'first-generation' (Traxler, 2006) focusing on ensuring the technology worked, learning happened and satisfying the funding criteria. At a local level, some recommendations (Traxler, 2006) for strategies to take wireless and mobile learning to a sustainable and substantial position have been fulfilled:

- The project has publicised valuable insights and given positive local visibility concerning the use of mobile technology.
- It has given a flavour for what could be achieved and invites imitation within HSC and other HE providers.
- It provides recognition that mobile devices are 'personal' and has helped to develop familiarity, expertise and confidence for students using them. All but one participant said they would continue to use the technology after the project phases completed if given the option. Several participants intended to, or had already purchased their own DS and Brain Training package as a result of using them.
- It has provided proof that this sort of mobile learning is reliable and robust on a technical level and can be viewed as a completely safe risk free innovation.
- It has identified the use of this technology as a credible platform for helping with numeracy which should enable high level 'buy-in' within any HE provider.

Other areas for more targeted research in the future could concern the sociability aspect of groups engaging with the software together rather than individually, which was not originally identified as a potential benefit. Using the wireless feature of the DS, Brain Training offers a calculation battle where up to sixteen players can compete to complete thirty sums. Whilst much has been made of individual benefits of mobile learning, this social aspect - mentioned by some phase one participants who met and learnt occasionally in small groups - needs to be studied in more depth. A participant from phase two has highlighted how students with Dyspraxia might benefit more from using some of the forms of training (Big Brain Academy) over others (Brain Training) which could also reward further study. Finally, the project has also helped to create an awareness of how mobile gaming devices could be used within a health education environment for patients. In the case of the AQB work, further research might consider linking the two forms of cognitive training groups together to obtain a realistic base line with which to measure future outcomes. More generally, there is also the emerging area of managing and tracking health and possibility of improving quality of life through the use of recently introduced software packages like My Health Coach (Ubisoft, 2008) which includes a pedometer and has been developed with a professional nutritionist.

Our next area of research, submitted but not yet approved under the HEAT 3 scheme, intends on focusing on the use of Maths Training supported by Brain Training. We are hoping to utilize a Symbol Digit Modalities Test (SDMT) allowing us to measure speed of processing and short term memory ability using a recognised psychological ability test of up to 12 healthcare students. We would then allow them to use the DS Lite with software for a six month period (October 2008 – March 2009) and re-test them to see if there is any improvement. We would also look to test an additional 12 students in a control group with no access to the DS or software to allow us to compare results.

We can conclude then, that presently, there are compelling reasons to add the Nintendo DS Lite and certain Touch Generation packages like Brain Training to any HE student support network as they provide a reasonably low cost, easily supported personal learning device for providing student support in certain areas (and potentially in the longer term as mobile tools for assisting with patient and personal well-being).

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Introducing Mobile Learning into Further Education (the Mobile Learning NETwork, MoLeNET programme) – Large-scale Research and Evaluation

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ABSTRACT
The Mobile Learning NETwork (MoLeNET) programme is a substantial one-year mobile learning initiative, involving £6m of capital funding from the Learning and Skills Council, taking place in the English Further Education (college) sector during the 2007-2008 academic year. As such, it is probably the largest single implementation of mobile learning anywhere in the world, involving more than 10,000 learners and 1,000 teachers/lecturers. This paper describes the overall research and evaluation activities being undertaken to support the 32 individual projects which are currently taking part in the MoLeNET programme, where much of the research data has only just been submitted at the end of the academic year. Full findings will be available at the MLEARN 2008 conference.

Author Keywords
Mobile learning, MoLeNET programme, research and evaluation

INTRODUCTION

The Learning and Skills Council (LSC) has supported mobile learning projects carried out by the Learning and Skills Network (LSN, formerly the Learning and Skills Development Agency) with partners since 2001. The first project, known as the *m-learning project* (see http://www.m-learning.org/archive/index.shtml), was an early pan-European research and development project which investigated whether mobile technologies could re-engage young adults aged 16-24 who were not in education, employment or training (the NEET group) and change their attitudes to learning and contribute towards improving their literacy, numeracy and life chances (a summary of the findings are contained in Attewell (2005)). The feedback from many of the tutors and mentors taking part in the m-learning project was that they would have liked to have been able to author or adapt the mobile learning materials provided to cater for the specific needs of their students in their particular context, and so the LSC supported a second project carried out by LSN and Tribal CTAD to create a 'Mobile Learning Toolkit'. This was piloted by 19 tutors in five Further Education colleges in 2005-2006 (the findings are contained in Savill-Smith et al, 2006).

Following these initiatives, and others such as the '*Learning2Go*' project (http://www.learning2go.org/) which focuses on the schools' sector, and the easy availability of high specification mobile and wireless devices, the LSC considered that the "concept and practice of mobile learning are well enough established to justify and enable a significant implementation of mobile learning within the English Further Education sector" (MoLeNET Invitation to Tender documents, point 8, at http://www.molenet.org.uk/involved/colleges/). The LSC made available £6m of capital funding, with colleges taking part sharing the cost by contributing 20% of the funding applied for towards the support, research and evaluation of the project being carried out by LSN.

Following a tendering and interview process, 32 projects in England were selected to take part in the MoLeNET programme. This paper describes the overall research approach being taken by the programme and its various research activities. Most of the data relating to the research was due to be received by LSN at the end of the academic year and much analysis is now taking place. Full research findings will be available at the MLEARN 2008 conference. Further information about the programme can be found at the project's website at http://www.molenet.org.uk.

THE MOLENET PROJECTS

As noted above, 32 projects are involved, which comprises 134 partners. Of these, 78 are educational partners and other partners include Work-Based Learning Providers, Local Education Authorities, City Learning Centres, Charities, Education Publishers, and Media companies etc. Each project either consists of a single college, or a consortia of colleges, schools and other partners, but led by a college. Six projects involve single colleges, and the maximum number of partners involved in a consortium is 13. Figure 1 below shows the location of the projects in England (either the single college or the lead college if a consortium). All the projects have in common the implementation of mobile learning but have different:

- Aims and objectives for their projects
- Local priorities
- Curriculum subject involvement (a selection are - beauty therapy, business administration, catering, childcare, construction, dental nursing, engineering, hairdressing, health and social care, literacy and numeracy and media)
- Learners' levels of study (a selection are – entry level qualifications to adult learning, NVQs, GCSEs, Specialised Diplomas, 'A' levels, BTEC and HND qualifications and Foundation degrees)
- Use different mobile technologies (Smartphones, ultra-mobile PCs (UMPCs), mini notebooks, PSP and DS games machines, voting devices, MP3/MP4 players and other portable multimedia players and PDAs)
- Learning contexts (eg whether they are issued to a learner for his/her long-term use, or used by individuals for field trips etc)
- Levels of mobile and e-learning maturity (whether the college/educational provider is new to mobile learning, or whether they were an 'early adopter' and so already had some mobile learning expertise)

Figure 27: Location of the 32 MoLeNET projects in England

More than 10,000 learners and 1,000 teachers took part in the MoLeNET programme, making it a very large mobile learning implementation programme, if not the largest in the world.

MOLENET RESEARCH QUESTIONS AND RESEARCH APPROACH

The MoLeNET research and evaluation strand of the programme has the following three research questions:

- How do colleges and consortia partners use mobile learning to improve teaching and learning?
- What is the impact of mobile learning on learners, teachers and institutions?
- Can mobile learning help to improve retention, achievement and progression of learners?

From the earliest point in the project, LSN wanted to ensure as far as possible that the projects taking part would want the research that they would be carrying out to be integral to the development and implementation of mobile learning in the projects involved. It was also keenly aware that it did not want to impose a specific research approach, rather that the colleges should be able to formulate questions which were appropriate to them which would then be used as the basis of their research activities and that this would, in turn, encourage further sustainability of mobile learning after the project had finished.

The research approach, Action Research, was chosen for the programme. This was considered the most appropriate approach because it is an attractive mode of research for practitioners (Koshy, 2006, page 2), and it can be seen as a "*possible solution to the problem of ensuring that research findings actually get used*". Elliot (1991) defines it as "*The study of a social situation with a view to improving the quality of action within it"*, and Griffiths (1998) "*the purpose of action research is, always and explicably, to improve practice'.* Much of the literature about action research emphasises that it is of a practical nature, involves people working and researching their own settings, and that the heart of the process is the desire to bring about change. It has also been identified as being particularly well-suited to the study of innovations, and, in particular, the use of Information and Communication Technology (ICT) in Education (Somekh, 2000).

The definition of action research used by the project is:

> "a research approach with the fundamental aim to help **professionals** (teacher researchers) to **improve practice** but also to **understand change processes**. It uses a cyclical process to diagnose issues for investigation, plan strategies, implement and review them, and reflect upon their findings".

LSN considers that by using action research, it will allow projects to:

- Focus on addressing college/teachers aims, not external programme aims
- Identify benefits for staff and learners
- Inform and improve practice
- Contribute to Continuing Professional Development (CPD) of staff, and the college profile
- Share good practice and practical lessons between staff and with other institutions

LSN was responsible for organising training in action research for the projects' Lead Practitioner Researchers (LPRs) who were nominated by each project to take charge of the project's research activities, including liaison with LSN, its data collection, analysis and reporting. Three action research training days were held for LPRs, with the idea being that each one was broadly linked to the action research cycle of diagnosis, planning, acting and review (NB the training relating to the first and second stages was combined, as the projects had already successfully submitted their tender documents which gave detailed plans of their expected implementation of mobile learning). LPRs were expected to cascade this training to members of the staff in the colleges. In addition, LSN has held two online conferences about action research for the programme (titled 'The dilemmas of the insider researcher', and 'Action research and change'). LSN has also delivered research methods' training (two separate days covering the development and operationalisation of questionnaires, interviews, focus groups, observation and written work such as diaries, logs, journals and blogs). To add further research support to LPRs in their own institutions, LSN visited all LPRs in projects after Easter (when the majority of mobile learning was carried out) and offered the opportunity to train staff in research methods/action research at those visits.

One of the major tasks for the LPRs was to formulate their research questions, and then to write an action research plan. These plans note the research questions, and the success criteria they would need to answer the questions, what needs to be done in a linear fashion, by whom, where etc, who would be responsible for this and stressing the research methods to be used. For some LPRs this was straightforward, whereas many needed a great deal of support and encouragement to structure their thoughts in this way, and the time involved to finalise these was under-estimated by LSN. Ultimately, 106 action research plans were agreed between the projects and LSN (approximately three per project). The foci of these plans and their success criteria can be grouped together under the headings of learning and teaching, student skills, and college/school issues in the following ways (NB they do not add up to 106, as some questions had more than one foci):

Learning and Teaching	
Supporting students' learning/Affordances	17
Teaching Experience	11
Independent Learning	6
Individualised Learning/Differentiation/Personalisation	3
Learning Styles	2
Collaborative Learning	1
Student Skills	
Communication (Student/teacher/tutor/mentor)	10
Engagement/participation/self-confidence/life skills	10
Motivation	5
Participation in class	3
Enjoyment/contemporary issues (student)	2
Revision	2
Organisational skills	1
Reflection (student)	1
Listening skills	1
College/School Issues	
Retention, achievement, progression, attendance	22
Learning resources/content/access	14
Virtual learning environments (VLEs)	7
Assessment	6
Course delivery	3
Costs of introducing mobile learning	2
Homework	2
Introducing change	2
Teachers' professional development	2
ILT	1

Implementation/curriculum integration of mobile learning	1
Effect of stakeholders	1
Library use	1
Other benefits (not associated with teaching and learning)	1
Student safety	1
Training in the use of mobile devices	1

Table 1: The foci of the finalised action research plans

It can be seen above that many projects wished to research the impact mobile learning has on student learning and teaching and student skills such as communication and engagement/participation in lessons etc. Many projects are also looking at the areas of student retention, achievement, progression and attendance which are key indicators of success of the sector. Some of the research plans focussed their research on particular groups of learners. The two largest groups were Work-Based Learners (15 plans) and learners who had Learning Difficulties or Disabilities (10 plans). Other subjects such as Construction, Arts, Modern Foreign Languages and others were stated, along with different levels and other factors to research (eg investigating gender related issues). This list does, of course, represent only the finalised plans agreed between LSN and the LPRs, the actual research undertaken may well be quite different when undertaken within the institutions.

LSN'S RESEARCH AND EVALUATION ACTIVITIES

LSN is responsible for the research, evaluation and dissemination of the findings of the MoLeNET programme. However, it is not a teaching institution, so the teachers and learners in the programme are based in the projects taking part. It is recognised that this does restrict LSN's ability to validate the research findings produced by the projects, so when there are opportunities to collect data directly from teachers and learners (such as using the SMS quiz engine – see below) these have been used and will offer a useful form of data triangulation.

LSN has asked the Project Managers and LPRs to complete final project reports. The Project Manager's report details the original objectives of the project and looks at various areas such as project success, how it has achieved national and local priorities, the numbers of teachers, learners and support staff involved, details the benefits of participation, the lessons learned, any health and safety or behavioural concerns of using mobile devices, comments on the funding model, sustainability and their future mobile learning plans. The LPRs report focuses directly on reporting the results of their research activities, how the use of mobile technologies affected teachers' practice (linking to the action research approach), any changes which may have taken place in the institutions as a result of taking part, the implications of the research, recommendations and reflections, plus also key messages for others.

LSN is analysing the responses to the questions across projects and producing a synthesis of the overall findings. The qualitative data analysis package Atlas.ti is being used for this, in conjunction with SPSS for statistical analysis. Following on from the work of Pawson and Tilley (1997), realistic evaluation is being used as the approach, as it is important for the Further Education sector to disseminate what works for whom, and it what context, in order to share the learning which has taken place within the MoLeNET programme. Each project's findings will also be available individually as case studies, in order that the context within which the mobile learning projects can be seen.

In addition to this work, LSN is also conducting its own research, as can be seen diagrammatically in Figure 2 below.

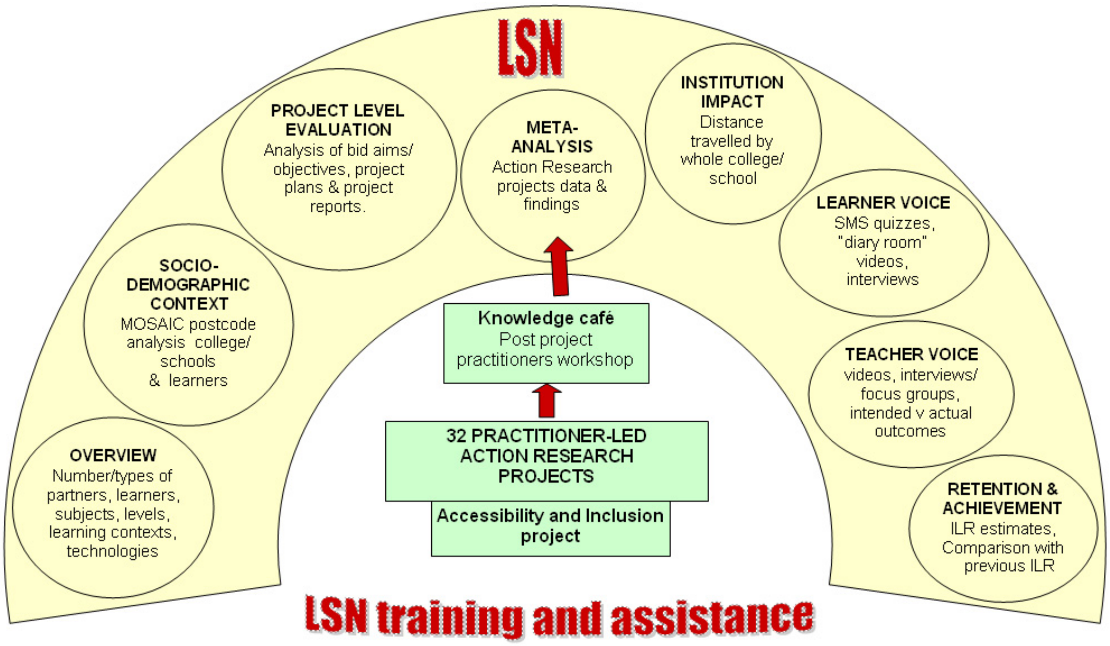

Figure 28: LSN's research activities in the MoLeNET programme

The diagram depicts the 32 practitioner-led action research projects as the very heart of the MoLeNET research programme, and all projects were brought together at an end-of-year event (which we termed the 'Knowledge Café) where the overall findings were discussed, which also helped to ensure reliability of the findings. There is another, smaller, but linked project which some MoLeNET colleges are participating which is directly related to reviewing good practice on the use of mobile learning by learners who have Learning Difficulties or Disabilities (LLDD). The yellow arch above the projects signifies the umbrella research activities being conducted by LSN, which include:

Project overview

Production of an overview of the project partners taking part, detailing their learners, subjects studied, levels studied, the learning contexts and the technologies used.

Socio-demographic context of educational providers and learners

An analysis of the location of the educational providers (colleges and schools) by postcode is being undertaken using MOSAIC socio-demographic software by Experian. This will build a picture of the educational providers' locations and associated areas which will allow LSN to describe the localities and the populations which the colleges serve (NB only those colleges and schools which had learners taking part in the project will be included). An analysis is also being also be conducted of the home postcodes of the learners (with their consent), which will allow LSN to build a picture of the areas in which they live compared against other indicators, such as ownership of home computers, to find out if, for example, it is the already technologically-literate learners who took part in the MoLeNET programme etc.

Project-level evaluation

As noted above, a project-level evaluation of the original aims and objectives of each of the projects, their project plans, together with the Project Managers' assessments of how successful they had been will be produced.

Educational providers' m-maturity work related to the distance travelled in the implementation of mobile learning

An analysis of the impact on the institution, of the distance travelled relating to the implementation of mobile learning, will be carried out. LSN refers to this a 'm-maturity' survey, which is a simple set of four questions with a number of possible answers, designed to assess where an educational provider can be placed on a matrix using a number of key indicators. This survey was carried out at the programme's inception, half-way point, and at the end of the project, in order to build a picture of the distance travelled during the course of the programme. Areas of examination are the interest and active involvement in mobile learning by the Senior Management team in an organisation, how teachers use mobile learning, the role of IT departments in supporting and enabling mobile learning, and the extent of use of mobile learning taking place by a provider. This has been informed by the work carried out by Becta into institutional e-maturity (defined as the e-enablement') is the capacity of a college or learning institution to make strategic and effective use of technology to improve educational outcomes (Becta, 2006). Some early findings are presented below.

The learners' voices

As noted above, LSN considered it really important to collect some basic data from the learners (so it is unmediated) relating to whether students consider the use of mobile technologies helps them learn, if it is enjoyable, makes lessons interesting, and whether they would choose courses involving mobile learning in the future. This was gathered using a text messaging system provided to the programme by Tribal CTAD (see http://portal.m-learning.org/sms_quiz.php). LSN ran a text messaging quiz in order to obtain a snapshot of how learners perceive mobile learning (see results below). This also has the added benefit of promoting the use of the SMS quiz engine, which has been provided free to all project members. LSN also requested projects to ask five learners to make a video of their mobile learning experiences to further capture the learners' voices. Thus, mobile technologies are being used to gather evidence about mobile learning.

The teachers' voices

As with the learners above, LSN has run a text messaging quiz with teachers to gather basic data to find out if they consider mobile technologies can help them teach and deliver resources, if they think its use is enjoyable and the impact they consider its use has on their students' learning (see results below). All projects were also asked to make a video of two teachers explaining their thoughts about mobile learning to further capture teachers' voices, again using mobile technologies to do this.

Individualised learner records

All colleges are required to submit data to the LSC each year in the areas of learner achievement, progression and retention. These are known as Individualised Learner Records (or ILRs). LSN has asked teachers to predict their learners' grades (n=10,000) in these areas, as the actual data from the current academic year is not available until 2009. Where possible, these will then be compared to the published details for the previous academic year, to find out if the use of mobile learning has had an impact on learners' achievement, progression and retention. Details of ILR work can be found on the LSC website at http://www.lsc.gov.uk/providers/Data/.

Thus with all the above ways of data gathering and analysis, a picture of the use and success of mobile learning in the MoLeNET projects can be built up from the perspectives of the Project Managers, the Lead Practitioner Researchers, the teachers and the learners for evaluation.

LSN'S RESEARCH FINDINGS

Timescales for the project have been tight which has had an impact on the elements of research. Many projects started their research later than originally anticipated, largely because of delays in device procurement – some managed to give their devices to learners from January, but others not until after Easter, which has meant that research periods for many projects have been condensed. Much of the data is currently being analysed and the results will be presented at the conference. However, the SMS quizzes noted above have closed and the findings of these will now be described below, followed by some partial evidence from the m-maturity questionnaires and evidence which has previously emerged.

Results of learner SMS quiz (n = 902)

- 70% of learners thought using mobile technology helped them to learn (22% said maybe, and 9% did not)
- 60% thought using mobile technology made learning more interesting (33% said sometimes, and 7% did not)
- 78% thought using mobile technology helped them to learn in different places (22% did not)
- 75% thought using mobile technology helped them to learn at different times (25% did not)
- 84% would like to use mobile technology for learning in the future (16% did not)
- 28% of learners had used the device for more than 3 months, 53% for between one and three months, and 18% for less than one month

Results of teacher SMS quiz (n = 112)

- 73% thought using mobile technology had helped their students to learn (25% said sometimes, and 2% did not)
- 71% thought using mobile technology made learning more interesting (26% said sometimes, and 3% did not)
- 46% thought using mobile technology helped them to personalise learning (50% said sometimes, and 4% did not)
- 86% thought using mobile technology had enhanced their teaching (14% did not)
- 89% would like to use mobile technology in the future (11% did not)
- 41% of teachers had used the devices with learners for more than 3 months, 40% for between one and three months, and 19% for less than one month

Reflecting on these results, they represent the views of about 10% of learners and teachers in the MoLeNET programme up to 4 July. Participation was entirely voluntary and was encouraged by the opportunity for both the learners and the teachers to win a mobile devices (iPod 'Touch'). In the learner consent forms which students signed to take part in the project, they agreed to sending at least one text message to LSN during the project, although it was recognised that some projects had bought data-only packages from their network providers and so the learners could not send SMSs from these devices. LPRs were asked to comment on the quizzes on their final report, and this will provide useful information to contextualise the findings above. However, it is interesting to note the high percentage of learners (84%) and teachers (89%) who would like to undertake more mobile learning in the future.

The m-maturity questionnaire

Institutions taking part in MoLeNET projects were asked to complete a simple m-maturity survey of four questions focusing on the attitudes and actions of senior management, teaching staff, IT staff and the position of the institution as a whole regarding implementation and embedding of mobile learning. The survey was completed three times, first in September 2007, secondly in April/May 2008 and finally in July 2008 in order to gauge distance travelled. Below are the graphs relating 31 institutions after the second stage:

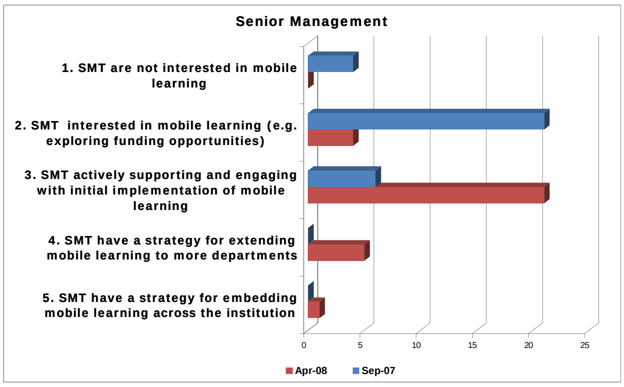

Figure 29: Views of involvement of senior management

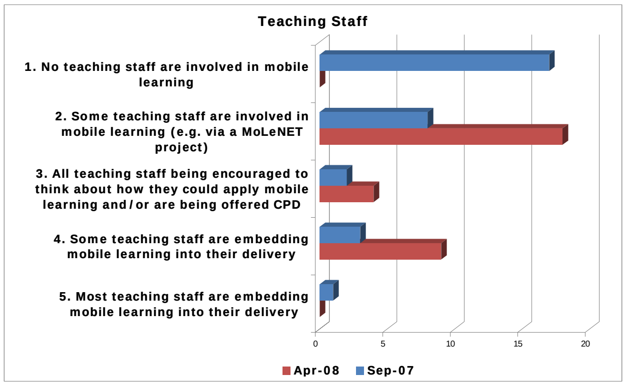

Figure 30: Views of involvement of teaching staff

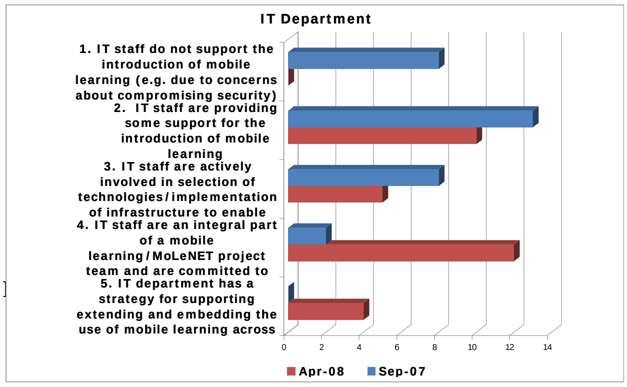

Figure 5: Views of involvement of IT Department

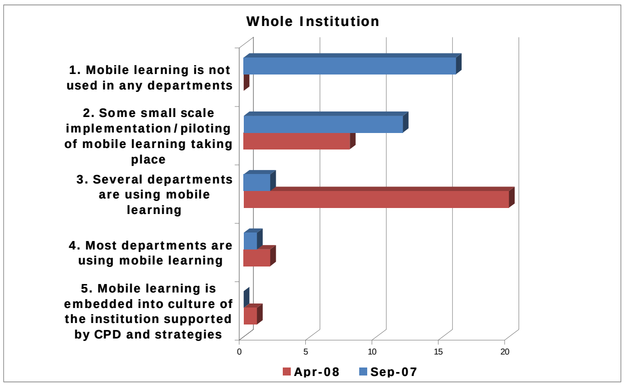

Figure 6: The use of mobile learning in institutions

The data relating to the 4 graphs above was analysed in SPSS using paired t-tests. At present, the results are highly significant with a clear difference being seen in institutions becoming more m-mature in all four areas (Senior Management Team, teachers, IT and institutions) which is as largely expected. The full m-maturity situation will be available at the conference.

ANECDOTAL/EMERGING EVIDENCE

Project Managers were asked to report evidence which was emerging in their bi-monthly reports to LSN. Below are some illustrative comments received prior to the final reports which give a flavour of what has been happening. The first links to an Ofsted inspector's comments, the second is student feedback and the final one is by a college principal.

> *"The College was just inspected by Ofsted who took great interest in our m-learning with Hairdressing students. An Ofsted inspector attended LoG Project launch event in Stockport and provided very positive feedback. The curriculum area involved in the project received Grade 1 and positive comments about inventive usage of ICT and mobile phones"* (Stockport College)

> *"The response from students has been nearly universally positive and we are very heartened by the speed with which they have engaged with the technology, the degree to which they can integrate it with their other learning activities and their judgements on its impact on their own learning. Students from a range of vocational specialisms, levels of learning and age profiles have been asked about their*

experience of the technology and they have been exceptionally responsive" (Kingston College consortium)

"I've been really delighted by the progress so far…. although we've only been doing this for the past year, (the benefits) are terrific and I want more of it"(Ruth Silver, Principal Lewisham College and Chair of New Improvement Body)

CONCLUSIONS

It is not possible to draw any firm conclusions from this programme yet, as the analysis of the data from the projects which took part is 'work in progress'. This study builds on two previous mobile learning initatives undertaken by LSN (Attewell, 2005; Savill-Smith et al, 2006) and is different because it is much larger scale, involves different types of learner and levels of study, a range of technologies used in different curriculum areas, different learning contexts, and the educational providers having different aims and objectives for their projects and meeting different local priorities. This paper describes the research approach for the MoLeNET research and evaluation programme, and some of its preliminary findings. The full findings will be available for presentation at the MLEARN 2008 conference.

ACKNOWLEDGMENTS

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Designing Participant-Generated Context into Guided Tours

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ABSTRACT

I am concerned to explore how mobile learning may evolve a set of processes that involve learners participating in and producing tours of the urban built environment that challenge notions of perceived authority and inaccessibility. In this, the learner is facilitated to construct new experiences, understandings and perceptions that reconfigure the role of the guide, guiding and guidance in tours. Public access to buildings and outdoor spaces, visitor education and participatory learning have emerged as broad themes in designing activities that position the tour as a mediating process in learning through and about the built environment. The focus for this paper is to consider theoretical perspectives on 'site' and 'context' that are relevant to designing learning activities associated with touring buildings. The paper concludes with a brief description of two new concepts for learning through touring, 'seeding' and 'threading', that have emerged from my wider practice in designing learning and touring projects with mobile devices. These processes aim to stretch ways in which participants may generate context in guided tours. My presentation will focus specifically on seeding and threading as concepts for learning in touring the built environment, drawing on case studies and practical application to demonstrate the concepts in action.

Author Keywords

Built environment, location-sensitive, guided tour, seeding, threading

METHODOLOGY

I have originated and designed a number of 'learning through touring' projects based in London from 2005-2007. These projects were located in a variety of places including everyday Deptford in South East London and institutional buildings such as the V&A Museum and the British Library.[33] Findings from these projects have contributed towards a conceptual framework for learning through touring that includes key concepts of 'seeding' and 'threading'. This paper connects some of the ideas drawn from the mobile learning community that are active in reinvigorating notions of 'site' and 'context' in the design of such projects.

MOBILE LEARNING AND BUILDINGS

In 2007, Mike Sharples suggested that the last ten years has witnessed a growth in mobile learning 'from a minor research interest to a set of significant projects in schools, workplaces, museums, cities and rural areas around the world. (Sharples, 2007a) A mobile learning community has evolved through these projects and it has been argued that this somewhat organic development, whilst important in allowing multiple perspectives on mobile learning to thrive, has also resulted in a form of pedagogy and practice that is difficult to define. (Winters, 2007) The term 'mobile learning' can be described as one still in the process of defining itself and is interpreted differently by the various individuals and organisations that have an interest in considering relations between mobile technologies and learning. Sharples describes three phases of development in mobile learning over the last ten years. He suggests that the first phase was characterised by a focus on handheld technology for formal education and training in which there was a concern with technology implementation and fixed locations such as classrooms. The second phase saw the development of 'learning across contexts' in which the emphasis was on 'how people learn across locations and transitions'. Sharples suggests that there was a focus on learning outside the classroom during this phase and projects based on field trips and museum

[33] Sprake, J. and Thomas, H., 'Transitional Spaces: Mapping Physical Change', *International Journal of Art & Design Education*, 26, 2, June 2007, pp. 167-176.

Mudlarking in Deptford: Online. Available HTTP: http://www.futurelab.org.uk/projects/mudlarking_in_deptford (Accessed May 2008).

visits evidenced this shift in focus from technology to learner. He describes a third phase of mobile learning as 'learning in a mobile world'. The elements for this vision he suggests are:

- 'Learning spaces – new types of technology-enabled indoor and outdoor space for learning, communication and knowledge working
- Pervasive technology – display screen on tram seat; interactive map of the city; activity trails; place notes
- Participatory design – technology to enable people to be actively involved in the design of their physical and electronic , environment' (Sharples, 2007b)

Of particular relevance is his emphasis on 'learning-enabled objects, buildings, cities' and that public spaces and buildings should be designed to support learning and creativity and how this might engage people in the participatory design of their environments. Sharples' notion of learning-enabled buildings can be understood through a concept of augmenting the built environment with digital information that can be activated by learners using ubiquitous technologies. The concept of digitally augmented environments can be seen to work in different kinds of urban location-based games and activities in which participants respond to located data using mobile devices as they move around a location in which a key aim is to make the 'invisible, visible'. For example, *Riot1831*, a project produced by Mobile Bristol[34] in April-May 2004 experimented with ways in which the movement and location of participants in Queen's Square, Bristol connected with fragments of an audio performance of the riot that took place there in 1831:

> It's 1831. Bristol is a tinderbox and the spark is Sir Charles Wetherell, the city's visiting magistrate, widely loathed for portraying the city as anti-Reform. The people are rising up and thousands have filled Queen's square to vent their fury and demand the Vote. […] In your backpack there is a receiver which 'knows' the location of the GPS satellites circling the globe. The receiver transmits your position to an iPAQ computer, triggering a sound file which plays through your headset. When you move on, you will receive another file. [35]

Projects such as this have informed development of active engagement with historical, social and cultural events enabled through the mobility of participants and location-sensitive mobile devices. The notion of context awareness can be seen in such projects in which the application is designed to provide participants with context that relates to their geographical location so that they virtually 'experience' an event by triggering media files through their own movement within a specific location. To consider the performance of *1831 Riot!* as an opportunity for mobile learning, discussion of interaction may focus around the nature of relations between participants and participants and their location in creating context to determine how learners may have opportunities for taking action. In this way, location can be understood in its capacity for interaction rather than as a passive 'background' to the activity. Sharples also seems to suggest that 'learning-enabled buildings' may enable context to be made through mobility of the learner rather than predefined by others. I would argue that there is potential for this notion of learning-enabled buildings to be developed further through a parallel connection with the material historicity of the built environment in which participants witness material change and transition of a building and/or location over time. This dual-dimension of 'learning-enabled buildings' sets up an opportunity for reconsidering a common definition of site concerned with the geographical location or legal ground space of a building towards a definition that emphasises site as a situated learning environment. In this, geographical location is dynamic in affecting relations between learners and between learners and buildings.

SITE AND SITUATION

It could be argued that the guided tour as a consumer product can be characterised by a centralised voice that operates through a transmission model of teaching, informing through communicating essentials. Selection of content for transmission can be institutionalised as a process in which the host for the tour and/or touring service provider makes decisions about type, mode and delivery of information concerning the substantive nature of a 'site'. Described as such, this traditional conception of the tour may generate practice based on the 'next generation' of the same model, for example, 'point, click and listen' devices (Fig 1) that allow users to select pre-loaded content as they move around a gallery, museum or tourist attraction.

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[34] A research project run jointly by The University of Bristol and Hewlett Packard Laboratories Bristol to 'push the boundaries of mobile computer technology and to test users' responses.' Information sheet for *1831 Riot!*

[35] Information sheet for *1831 Riot!* Online. Available HTTP: www.mobilebristol.com and www.roaring-girl.com (Accessed April 2004).

Fig 1: 'Point, click and listen' audio device, Fundació Joan Miró, Barcelona, 2004. Photograph: Juliet Sprake

Kristóf Nyíri suggests that 'situation' is important in understanding the interdisciplinary nature of mobile learning and, I would argue, this provides a point of reference for differentiating between what may be meant by site and situatedness of the learner. He says, 'above all, the problem of unity of knowledge is once again a topical issue. The situation-dependent acquisition of knowledge that is made possible by mobile learning transcends the boundaries of traditional disciplines'. (Nyíri, 2003) Situated learning has been described as taking place within an 'authentic' context (Naismith et al, 2004) although I would argue that who or what determines authenticity of the context is very much open to debate. The two photographs in Fig 2, for example, show the Gilbert Gayes Gallery at the V&A Museum in London during and after refurbishment in 2005 and prompts questions around the nature of what makes for an authentic context, a picture of the finished article or of the work-in-progress.

Fig 2: Gilbert Gayes Gallery, V&A Museum London. Photograph: Futureplan representative, V&A Museum

One important aspect of development in mobile learning concerns the use of mobile devices based on the notion of a 'fixed' location such as a classroom, gallery or museum to record information, vote on an issue or find out more about something from an expert. In this, learning can be described as 'situated', and the context as authentic from the point of view of a museum curator or designer of an exhibition guide. Yet situated learning is also about the influence of our everyday environment on us, how we respond to events that may be incidental, unintentional or accidental as subjective learning opportunities. I would argue that situated learning involves affecting a shift in thinking from site as geographical location to site as context for learning. Site is actively produced through interactions between learners rather than a predetermined given. The expectations and formulae embedded within the notion of context as a physical location makes the learning situation dependent on the specifics of the ‘classroom’ environment. The situatedness of the learner may instead be understood if we conceive of situation as an ‘elastic environment’[36] in which the social and spatial production of meaning is what situates the learner. This challenge in itself offers an innovative platform for developing learning as a social and dialogic process in relation to a way of exploring the built environment in which both learners and technologies are mobile.

Constructivist and co-constructivist theories of learning also provide insight into understanding site and situation in mobile learning. In constructivist theory, learning is ‘conceived of as a process of adaptation in which the learner’s view of the world is constantly modified by new information and experience […] Co-constructivism emphasises that such learning is necessarily a social process in which language and dialogue are primary. These dialogues take place between individuals who are socially situated within historically and culturally specific learning environments.’ (Burgess and Addison, 2007) This approach to learning opposes a didactic or behaviourist approach to education that identifies the teacher as the main source of knowledge and as one-way information delivery. A co-constructivist approach to learning engages *multiple* learners in collaborative activities. Educational perspectives on co-constructivism highlight the inseparable nature of people and environments in situated learning theory in which emphasis is on creating opportunities for developing ‘situated and socially shared cognition’ (Reusser, 2001):

> Situated learning theory views human cognition as being embedded in and inseparable from specific sociocultural contexts. […] At the heart of this concept of co-construction are two coexisting activities: collaboratively solving the problem, and constructing and maintaining a *joint problem space*. (Reusser, 2001)

I would argue that ‘site’, used as a term to describe a learning environment, may be more complex than a ‘joint problem space’. Sites could be personally constructed spaces for learning that may or may not be publicly acknowledged and shared by a group. A site may also be a combination and/or layering of real and virtual elements as can be seen in buildings that are digitally augmented with information. A site may also be described as a transient space such as a bus journey or a short-cut between buildings. Understanding learners as situated can involve debate on such interpretations and uses to differentiate and evolve what might be called situated learning environments or ‘sites’. In their description of a gallery-based art project involving young people, art and design educationalists Lesley Burgess and Nicholas Addison[37] link ‘learning environment’ with ‘pedagogic situations’ in describing a co-constructivist approach to learning in galleries. They importantly highlight that ‘values accruing to these environments enact specific power relations’ need to be acknowledged before ‘mutuality’ between learners and teachers can be developed.

In designing participant-generated context into tours, I would suggest that ‘site’ is understood as space that provides opportunities for collaborative learner interactions related to their geographical location. A critical element of this is exploration and discussion of issues associated with power relations that may affect construction and maintenance of that space. The situatedness of learners can thus be defined through social and spatial production of meaning. It is therefore important to explore how context has been defined in mobile learning and how this may be relevant to designing learning activities that provide opportunities for developing understanding of site through the situatedness of participants in the activity.

CONTEXT

If site, situation and social interaction are conceived as fluid entities in mobile learning, learning activities in tours can be argued to be designed around individuals constructing personal and spatial contexts with others over time. The dislocation between spaces and times and the juxtaposition of familiar and unfamiliar, for example, can serve to ‘jolt’ learners into making new spatial contexts in creative ways. It could be argued that this dimension of mobile learning necessarily shifts the focus from the learner as a spectator of media to that of a maker of media as s/he participates in negotiating his/her way within, through and between these different contextual interactions.

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[36] The term ‘elastic environment’ is taken from Mikhail Bakhtin’s notion of a ‘dialogised atmosphere’ in which spoken words take shape when uttered. In this he describes the dialogic nature of language as socially and historically determined. M.M. Bakhtin, *The Dialogic Imagination*, Minneapolis: University of Texas Press, 1981, p.276.

> All activity is performed in context. Cole (1996) makes an important distinction between context as 'that which surrounds us' and context as 'that which weaves together'. But context is never static. The common ground of learning is continually shifting as we move from one location to another, gain new resources, or enter new conversations. (Naismith et al, 2004)

Sharples has developed an understanding of what it means to be a mobile learner through an application of Gordon Pask's 'Conversation Theory' to explore how 'context' arises out of constructive interactions between people and technology. (Sharples, 2007c) Sharples asks what elements are necessary for a productive conversation either with another or with oneself and suggests that conversation is a necessary system for learning based on an application of Pask's notion of distributed cognition in action. He argues that context is created through interactions between people, technology, objects and activities within a pervasive computational system that enables appropriate actions for example, learning. Sharples describes this view of context as one that is 'woven'. Context is here continually created by 'minds in motion' within a distributed, interactive computing system. He also describes a more normative understanding of context as a 'shell' that 'surrounds', an interpretation that can be seen in educational settings in which learners are recipients of information. Sharples argues that an understanding of context as 'shell' is based on an illusion of stability and suggests that whilst entertainment contexts have developed from 'shell' to 'woven' or interactive, educational contexts have largely remained as 'shells'.

The tour may be generally recognised as a context for learning, a type of educational activity in which there is an expectation to 'be informed'. Who names the tour as a context for learning, the designer or participant has implications for the kind of learning that may or may not happen. The notion of a learning context is further complicated by participants being able to apply resources, skills and knowledge from one context in another, especially if the context is not formally recognised or described as a learning one. This prompts the question whether it is possible to differentiate between learning and non-learning contexts at all in lifelong learning. Educational theorists Richard Edwards and Robin Usher (Edwards and Usher 2000) identify a similar set of complications and suggest, whilst there is no easy answer, that there are two ways in which context may be conceived that, I would argue, echoes Sharples' notion of 'shell' and 'woven'. They describe context as 'a bounded container within which learning takes place' and also as a 'networked and relational set of practices wherein a learning context is an effect of specific practices of contextualisation.' This notion of a 'container' is expanded upon to describe context in spatial terms as a way of structuring or confining learning that produces a 'space of enclosure'. In contrast, the notion of context as a 'set of practices' distinguished by processes and outcomes is one in which 'pedagogical space emerges'. I would argue that understanding context as 'woven' opens up, for example, opportunities for reconfiguring the concept of 'points' on a conventional guided tour; pre-defined points of interest that are structured around a 'container' or 'shell' notion of context. Points of closure sequenced in such a way as to provide knowledge to inform learning characterise the structure of a conventional tour. These points may be numbered or mapped to define a route and specify knowledge as discreet entities. Understanding context as 'woven' and the practices and processes that contextualise, I would argue, makes the concept of 'points' difficult to pursue in designing tours as learning activities and suggest that a term such as 'node' may be more appropriate in enabling opportunities for participants to make incidental connections between each other, the location they are moving through and other sites. Edwards and Usher suggest that:

> If contexts are not inherently bounded, but are bounded through forms of interconnectedness that make certain relations and erase others, then the ways in which we understand learning between contexts is also opened up for exploration. (Edwards and Usher, 2000)

The notion of 'woven' context can be developed further by considering the ways in which context may be subjectively conceived by being mobile in the built environment and the kind of learning and touring processes that may facilitate weaving this. Edwards and Usher use the term 'polycontextualisation' to describe the potential for learning contexts to be 'mobilised in a range of domains and sites based on participation in multiple communities of practice.' These authors argue that learning and practices that are 'polycontextual' enables consideration of transferability that is not solely cognitive-based but recognises that relations are made through 'artefacts, affinity groups, storylines, emotions.' In other words, 'polycontextualisation' relies on spaces being created that may facilitate these relations rather than the cognitive ability to transfer knowledge, skills and understandings to another 'contained' context. The tour may be conceived as learning activity in which participants make connections between past and present, one site and another. I would argue that the tour may engage multiple perspectives and voices in bringing about opportunities for weaving context. Polycontextualisation in mobile learning may involve creating conditions for making spatial, temporal and social connections between artefacts, multiple perspectives, narratives and emotions. I have developed two concepts for mobile learning through touring that, I would argue, provide opportunities for such connections and associations to be made.

SEEDING AND THREADING

Spatiality, temporality and social interactivity have formed key elements of a framework I have developed from Jane Rendell's notion of 'critical spatial practice' (Rendell, 2003 and 2006) for exploring how practices of touring and approaches to learning may be mutually transformative. These may be summarised as: the spatial ability of learners to orientate expressed through taking action (spatiality), learners developing awareness of how a notion of 'out of context' can be creative by making associations between the present and past, one location and another (temporality) and learners co-constructing meaning through speaking and listening generated by generic shared expectations of the tour (social interactivity). This framework has been developed through my practice in designing learning through touring projects involving young learners in a variety of locations.[38] Two new concepts for stretching understanding of what might be meant by 'woven' context in practices of touring are 'seeding' and 'threading'.

Seeded content or subject matter is designed to be evolved by other participants on the tour and is organised into nodes. Nodes are defined as geographical locations, marked on a map, that link conceptually through the minds and movement of participants. Starter nodes are initiated or 'seeded' by a group of mobile learners who gather and edit content that can potentially be evolved by others. This process is termed 'seeding' and the subject matter for each node, 'seeded content'. The concept of seeding also describes the potential for starter nodes to change and develop over time as others (including 'experts') add their own content. In this way, seeding is designed to support subsequent participants in posing questions, concepts, issues and imaginings that are activated by being in location. Interaction with seeded content is supported by mobile devices that record, store and present data in location. The notion of time-space is integral to the concept of seeded content in that the actual time and space of interactions informs what the participant contributes to the evolving content on the mobile device. Threads are made by walking between nodes and responding to seeded content. Whereas a theme may be declared at the start of a tour or emerge through the guidance, threads are produced through active participation in the event and are dependent on the specifics of social interaction, time and space. Threads are formed by participants making connections between the seeded content and their location as they walk from node to node. As such, new connections between the nodes may initiate new threads of enquiry over time, with different participant groups and offer possibilities for making associations with issues, stories and narratives with in other locations. Overall, the concepts of seeding and threading support participants in developing a heightened awareness of transition (both materially and through use) in the built environment and that it is they who are active in producing the tour rather than the guide. A notion of out-of-context is particularly important in developing this kind of heightened awareness, using the concepts of seeding and threading to develop skills in 'noticing' what may be considered odd or strange in a seemingly ordered and planned built environment. Mobile devices can support learners being 'jolted' into making these associative connections with their location and between locations.

IN CONCLUSION: LOCATION-SENSITIVE TOURS

I would suggest that a notion of location-sensitivity in mobile learning may focus less on technologies that assist in marking positions of participants on a tour, and more on consideration of the ways in which they shape subjective associations with buildings. Making connections between user accounts, drawing attention to specific things in the fabric of the building, layering historical information about the building in its contemporary setting are examples of ways in which the tour as a social, temporal and spatial operation can be argued to be uniquely positioned to inform opportunities for mobile learners to have 'conversations' with buildings in which buildings are understood, as architectural historian Thomas A. Markus suggests, as an 'interface between objects and people.' (Markus, 1993) Setting up conditions for having those conversations I would argue emphasises a need for developing activities that focus on mobile learner attributes of 'stumbling upon', 'noticing' and 'connecting' with the transitory and dynamic nature of the built environment so as to develop the notion that buildings and their environs may facilitate weaving of context.

This notion suggests that mobile learning embodies the technological means to change the expert/lay relationship in tours. If relations between participants, artefacts and their environment are dynamic (rather than an unwanted

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[38] *Mudlarking in Deptford*, *Transitional Spaces at the V&A*, *Cracking Maps at the British Library* and *No Lingering in Lewisham!* were projects originated by myself and developed in collaboration with others between 2005 and 2007. These projects contributed significantly to the naming and definition of these concepts. For further details see:

Sprake, J. and Thomas, H., 'Transitional Spaces: Mapping Physical Change', International Journal of Art & Design Education, 26, 2, June 2007, pp. 167-176.

Mudlarking in Deptford: Online. Available http: http://www.futurelab.org.uk/projects/mudlarking_in_deptford 'distraction' to learning), 'stumbling upon', 'noticing' and 'connecting' may become key attributes of the mobile learner. In this, the built environment is conceived of as 'learning-enabled' in a third phase of 'learning in a mobile world' where *mobilised* learners take action through being in location. This process is initiated through interaction with what is noticed; where action is taken develops knowledge about the object. Personal appropriation and shared transference of meaning offers those concerned with designing tours for learning the scope to disrupt one-way delivery models of educational tours. The speed at which walking happens, accelerations and decelerations, different perspectives (from top-down viewpoints to immersive jostling) affect the way in which people move through space, and what they notice and where they go next. The experiential physicality of motion, momentum and position throws up productive opportunities for exploring technologies that enable tours to be initiated and evolved through active participation in creative processes of subjective recontextualisation.

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Language Learning ‘On The Go’

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ABSTRACT

This paper describes an initiative to produce multimedia language learning activities for students to use ‘on the go’. The rationale for this work is discussed, which sets out our approach towards language learning and the potential for mobile learning. Five prototype activities have been developed and evaluated with students. The design of the prototypes and the issues involved in developing them are outlined, and each of the prototypes is described and illustrated with examples. Some of the results from the student evaluation are presented. The paper concludes with some recommendations of how this initiative can develop and be taken forward in the future.

Author Keywords

Language learning, mobile learning, mobile phones, multimedia, student evaluation

INTRODUCTION

This paper discusses an initiative that is experimenting with the development of multimedia mobile learning activities for Higher Education language learning modules. Online learning activities are already provided for students, and what is currently offered is described in the background section. The paper then highlights the pedagogical and technical issues surrounding the repurposing of online materials for the mobile phone. Five prototype activities of different types have been developed, and these are described and illustrated with examples. These prototypes have been evaluated by a group of students, and the paper reports on the findings from the evaluation questionnaire and focus group before making recommendations for future developments.

BACKGROUND

The Open Language Programme (OLP) at London Metropolitan University offers foreign language study as an additional subject to more than 3000 undergraduate students per year. The programme also includes language degree students, members of staff, and members of the general public. The profile of the learners has a significant impact on the delivery and format of the programme: 70% of students are mature learners from non-traditional backgrounds and of diverse origins. The programme is delivered through a blended study mode: students attend a 3-hour class every week and complete 3 hours of self-study online through a package called the London Met e-packs (http://www.londonmet.ac.uk/e-packs). The e-packs have been designed in Adobe Flash and offer visually attractive, interactive exercises which allow for the combination of sound, images, graphics, videos and text within a single activity. Learner feedback and support features are included in a wide range of levels and ways, allowing for a variety of learning styles. The package is being used by a number of Higher Education and Further Education institutions on a commercial basis.

Each language package contains 11 topic-based units which are divided into 10 activities allowing learners to practise the language learning skills of listening, reading and writing. There are also activities giving grammar practice and cultural tips. Learners are involved in a variety of activities such as matching, gap-filling, reordering and multiple choice questions through games and task-based activities. One aim of the e-packs is to engage learners actively in the language learning process through motivating and fun exercises. Prensky (2007) states that whilst most teaching happens in a linear way through presentation and telling and in a format that fits all, 21st Century’s learners (digital natives) learn from being engaged, by doing, through game play and exploration, whilst multitasking online. In this context, the London Met e-packs are an attempt to engage, motivate and break traditional barriers for these learners. In previous studies on the use of e-packs learners have highlighted the flexibility of the package as a main contributor to their language learning in autonomous mode. They cited being able to plan their learning in terms of place, time and amount of content, and they were also able to develop personalised learning strategies through choice of exercises and through accessing the scaffolding or support features.

LANGUAGE MOBILE LEARNING

Mobile technologies are particularly appropriate to the teaching of languages and can be used creatively to foster a rich learning environment. They can also provide increased opportunities for learners to have more control over when, where and how they learn. There are approximately one and a half billion mobile phones in the world today, which is more than three times the number of PCs. Mobile phone penetration amongst students and young people in the developed world is between 75% and 100% and the consensus is that m-learning will play a major role in the next generation. Research suggests that m-learning can motivate and engage young people in a way traditional methods cannot (e.g. Stead, 2005). Prensky (2004) states that the inescapable rise in the use of mobile technologies amongst native and immigrant learners drastically challenges the way in which educators approach learning materials design. A mobile learning survey at London Metropolitan University (Cook et al., 2006) indicates that learners place a high priority on learning at any time and any place on their phones.

Although the use of mobile technologies for language learning is still limited to a few focused projects, the benefits of language m-learning have been well documented (Kiernan & Aizawa, 2004). Their project focused on vocabulary practice in which students in pairs would communicate via text messages or speaking directly to each other, and their conclusion was that mobiles represent a language learning resource worthy of further investigation. A project at Athabasca University is providing grammar lessons with interactive exercises for ESL adults (Ally et al. 2007), and also reports on other examples where ESL and other languages are being taught using mobile devices, usually for specific tasks, e.g. teaching pronunciations, listening skills, and tenses. More generally, Kukulska-Hulme reports that mobile devices are currently used for learning in four main ways (Kukulska-Hulme 2006): to help communication, for content delivery and creation, to promote personal engagement and for contextual learning. Our project focuses on interactive multimedia content creation and the personal engagement of learners. It is clearly an extension of the work already undertaken for online delivery and concentrates on the affordances that mobile technologies can bring to learning. The potentials for contextualised learning and learning-related communication are not excluded and will be considered at a later stage in the development of the project. In this context and in order to offer learners access to a complementary language learning experience, this project investigates the potential of mobile technologies for learning languages by selecting a number of activities from the London Met e-packs to be adapted for the mobile phone. The student evaluation has concentrated on eliciting the student response towards mobile learning and the activities developed.

The initial choice of the activities to be transferred was equally based on the technological features (videos, text, games, graphics etc.) most likely to suit the mobile phone and the pedagogical needs of learners (listening comprehensions with scaffolding activities, grammar support etc.). From the outset, it became clear to the designers that contrary to an online delivery, where learners are offered a full multimedia experience on one screen and where the designer has an opportunity to insert layers of learning support within a wide range of assets, a mobile delivery significantly limits this potential. A challenge then arises for the practitioners, as it seems that the more mobile the learning activities are, the less pedagogically challenging these activities become. Indeed previous work by Herrington and Herrington (2007) found that the uses of mobile devices in education appear to be:

> “predominantly within a didactic, teacher centered paradigm, rather than a more constructivist environment. It can be argued that the current use of mobile devices in Higher Education (essentially content delivery) is pedagogically regressive”.

It is important to note that the design process may have had an influence in the perception of the quality of the materials created. These were mostly existing exercises designed for an online multimedia context for use in a self-study mode and then adapted to mobile devices. This sometimes meant that some exercises on the mobile phone did not have all the interactive functions present available online. If the statement above about regressive pedagogy is true in our context too, we need to establish whether learners feel that it is hampering their language learning experience or whether they rate other criteria higher as a measure for a successful learning experience.

DEVELOPING FOR THE MOBILE PHONE

Technical issues

Whilst the multimedia developer was experienced in developing a range of media for online delivery on the PC, developing for the mobile phone was a new experience. There were thus a number of considerations and practicalities to take into account before the development of the activities could begin in earnest. They included issues of designing for the smaller screen size and the functionality of the mobile phone, including the interface, use of the available phone keys and navigation. However, colleagues within the University had been developing learning materials for mobiles for a couple of years, and some of their experience in finding solutions to these issues has fed into this work (see Bradley et al. 2007).

From the outset, a couple of technical directions were chosen for these mobile prototypes. Firstly, the decision was taken to author the activities in Adobe Flash Lite, largely because the e-packs were developed in Flash, and there was a requirement to try and retain the rich use of multimedia, graphics and interaction in the mobile activities. We chose to author in Flash Lite version 3, as it would enable us to experiment with the use and control of video on the phone more effectively, which was a component we wanted to include in the activities. Secondly, we chose to develop the prototypes for the Nokia N95 phone, as the RLO-CETL had been working with these phones because of their multimedia capabilities, the reasonably large, high quality screen size (2.6", QVGA 240 x 320 pixels, TFT display screen with ambient light detector that can display up to 16 million colours), and the large internal memory (160 MB internal memory). The N95 however, whilst being a top of the range handset, was widely used in the UK, and becoming cheaper and therefore likely to be owned by students in the near future. Choosing one model of phone to develop for initially mean that we could concentrate on the pedagogic design and activity functionality without the added complexity of designing for multiple handsets and specifications. Initial attempts designed for the Nokia N91 in Flash Lite 2 lacked many of our intended core attributes. Flash Lite 2 was limited in its coding and any video content involved using a separate file converted to 3GP (a format uniquely developed for mobiles) that could not be controlled by the Flash activity itself. The screen size of the N91 phone at 176 x 208 pixels definitely limited the scope of our designs.

Functionality

There are two key areas to consider regarding functionality. Firstly the use of the phone keys to navigate through the activities and the use of the keys within the activities themselves. A detailed investigation into how the phone operates was undertaken before determining our choices. When beginning to author and experimenting with what was possible on the mobile, Adobe's Flash Lite Content Developers Kit (CDK) was very useful, containing authoring guidelines which covers tips, techniques, interface elements, examples and tutorials for developing Flash content for mobile phones (Adobe website). The CDK is most helpful in obtaining information about scripting functions, such as setting the size and quality of the screen, determining the functionality of the soft keys. There are also other various online resources and developer forums, which were crucial in understanding mobile technologies (see 'useful web resources for developing Flash Lite applications' in the references section).

The Nokia N95 operates in a similar way to most other advanced phones. It uses a standard 4-way navigation key with an 'enter' or 'select' key in the middle and two 'soft' keys that enable the user to select information on the phone, which can be programmed to change according to the page or screen viewed (see Figure 1 for an illustration of the N95 navigation keys). For example, the left soft key often represents an 'options' button, which when selected, produces a pull up list with a number of options. The navigation keys are then used to scroll up and down the list and the 'enter/select' key is used to activate that choice. On the N95 the front of the phone is pushed up to reveal the alpha numeric keypad.

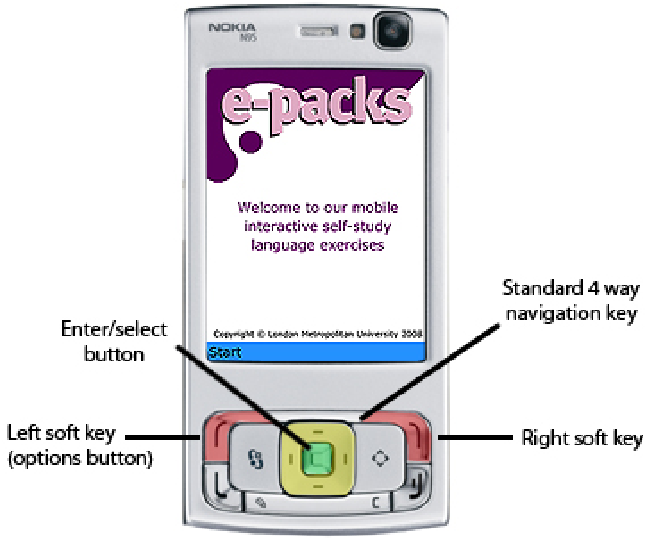


Figure 1: The Nokia N95 fascia indicating the main operating buttons

After some experimentation, two basic methodologies for phone use have been adopted for our design:

1. All navigational controls are accessible from 'options', accessed by pressing the left soft key button, for example, 'next page', 'previous page', 'home' (back to the beginning) and 'quit'. When appropriate, and depending on the needs of the activity, further options become available, for example, 'help', 'play audio', 'vocabulary help', 'transcript', 'submit' and 'clear'. See Figure 2 for an example of the 'options' in one of the activities.
2. This approach enables the 4-way navigational keys to be used to navigate through and select the appropriate content elements within the activity, using the centre 'enter/select' key to activate a selected item.

In effect, 'options' functions as a pop-up menu, containing all the necessary navigational choices the user will require to access all the content and move through the activity. This method for accessing the navigational choices ensures it is available at all times and frees up valuable space on the active screen for the display of content. When the 'options' are displayed on the screen, the right 'soft' key becomes a 'cancel' button to take the user back to the options free screen (see Figure 2).

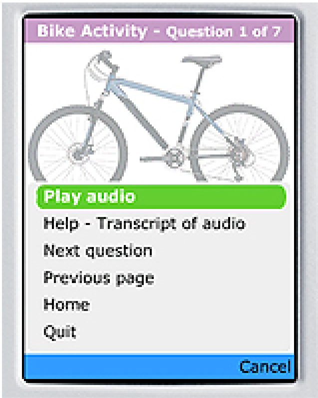


Figure 2: An activity with the navigation options shown on the screen – these are accessed by pressing the left soft key to choose 'options'

This distinction of having a separate system for navigating through screens/pages or parts of the activity from selecting content within the activities was devised to simplify the use of the phone buttons for the users. This navigational system allows the user to be just two clicks away from anywhere within the activity or to quit the activity.

Flash Lite also allows the designer to pre-select the 'focus' button on each screen, which is the button or element which is highlighted (for example in Figure 2 above, the 'focus' is given to 'Play audio' in the options menu). This allows the designer to highlight the button most likely to be accessed first by the user.

Aesthetics

Each activity was designed through a storyboard and a timeline and the aim of transferring the online activities to the phone was to keep most of the design attributes as close to the originals as possible where this was feasible. However the underlying design and layout of each activity generated specific issues as it was developed and these are raised when we describe each of the prototype activities in the next section.

Choice of colours, type of font and size of text are important and affect the look and feel of the activities and the overall experience for the user. We chose to use 'Verdana', an easily legible sans serif font at 12pt size, influenced by the text used in menus and for options in the N95 interface. We also mimicked the functionality and appearance for the 'options' button to retain familiarity for users, using a coloured bar to highlight each option as you navigate through the list. For the main interface, a blue information bar at the bottom of the screen is used as the main navigation point for users. A purple information bar at the top of the screen indicates to the users where they are in the activity or what question they are currently doing. The colour schemes adopted are intentionally similar to those in the e-packs to retain the branding and graphical appearance in the mobile activities.

In order to create a visually appealing activity that is easy to use and navigate through without the screen becoming cluttered, each activity was designed with 'space' in mind. Graphic design principles of creating symmetry and aligning items on a 'grid' were used, and with careful design it has been possible to achieve a spacious and attractive layout, even with the constraints of the smaller screen size of the phone.

THE PROTOTYPE ACTIVITIES

We chose to adapt three activities from the French online e-packs and to create two new activities that were specifically designed to utilise the strengths of the mobile phone.

1. The Vocabulary activity

This activity uses multimedia to develop multiple language skills, retaining the ethos of the original online activity. The aim of the activity is to understand instructions in French. It starts with the students listening (via the 'options' button) to instructions on how to build a bike from a kit. Learners are required to identify the parts of the bike through the listening comprehension and to select them through a semi-authentic task. The parts of the bike are shown graphically and they have to select the correct vocabulary from the options given on the screen. Help is available in the form of the transcript of the audio instructions.

This activity underwent serious changes from its original e-packs design. In the original this activity was a drag and drop, where the user dragged the words to the appropriate position on the bike. This would not have worked on the phone screen as the bike would have been too small to see. The activity was therefore designed so that the bike is animated and zooms in to highlight the part of the bike to be named. Then the user just navigates through the terms given using the 4-way navigation key and selects the appropriate one. There are 7 questions to complete, and after selecting the correct response the user is automatically taken to the next question. If an incorrect response is given, the user is notified and given an opportunity to reselect.

2. The Grammar Quiz

This is a grammar quiz dealing with relative pronouns while describing places in French. It is a multiple choice activity designed as a game in which learners have to score the maximum amount of money. The activity tests the ability of learners to select the appropriate relative pronoun in a sentence. This activity is an attempt to lighten the drilling aspect of grammar practice and to engage students through game play. Every time a question is answered correctly, the learner increases the amount of money they win and a jingle validates their choice. Once all answers are correct, they become millionaires. Users have to navigate to their chosen word, and once highlighted they 'submit' their choice. A correct answer takes them to the next level and a chance to win more euros, but an incorrect answer takes them back to the beginning of the activity. There are 10 questions in total. For this activity the navigation system is simplified. The 'options' menu is not required, as the pedagogy of the activity dictates that when you 'submit' a question you automatically go to the next question or back to the beginning, depending on whether the answer is right or wrong. The only navigation options needed are 'home' and 'quit' which are activated by the 'soft' keys and labeled on the bottom information bar.

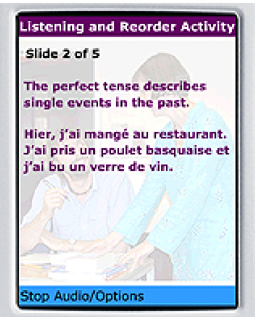
3. The Video True/False activity

One of the aims of adapting this activity was to assess whether video activities from our existing e-packs could be successfully transferred to the phone. Flash Lite 3 allows the support of FLV files (Flash's own video format) which makes it possible for the video to be played within the flash object. This also allows for better control of the video and a much better image quality compared with the 3GP format that was previously available.

This activity is a listening comprehension based on a video clip. The context is describing people in French. It is a true or false activity which allows learners to judge the veracity of a statement contained in the video. The scaffolding/support features include a transcript of the dialogue in the video and vocabulary help. The visual aspect of the video supports the understanding of cultural differences (kissing, hand gestures, colloquial expressions etc.).

Students first access an initial instruction screen that explains what they have to do. This leads to a screen where they can play the video and answer the first of eight questions. The user is given a choice to select 'true' or 'false' to each question. A correct answer takes the user to the next question. There is a subtle difference to the way the online activity worked. With more space on the web page the original activity showed all the questions at once, here however each question is presented separately onto a single screen. The activity also comes with vocabulary help and a transcript, which can also be selected at any time using the options button. The video can also be stopped and played again at any point during the activity. Initially the video file was an external file, however it seemed that after playing for one minute the link closed down, which was extremely disappointing as we had hoped that by having the file externally we could reduce the amount of working memory the phone would be using, which is sometimes an issue with rich multimedia content.

4. The Grammar Presentation activity



This is the first of two activities that were designed exclusively for the phone and were not adapted from the e-packs. This activity involves listening to a $2^{1}/_{2}$ minute dialogue between a teacher and her student about a grammar point (the French perfect tense). While listening to the explanation learners can see a text-based summary of the key points, similar to a PowerPoint presentation supporting the audio. There is also a word order exercise which illustrates the grammar point. It is designed as a game, and the user is given a minute to reorder a sentence. There are 5 reorder sentences in total. The user selects each word in the order it should appear in the sentence, and when finished they select the options button and submit their completed sentence. If the user runs out of time a help screen appears which allows them to hear the correct sentence. You then have the option to go back and attempt the question again.

5. The Vocabulary Search activity

This activity focuses on vocabulary used to describe people. For each question a sentence is displayed with a missing word. The user has to locate the appropriate word on the grid and then navigate and select each letter completing the sentence. There are 5 questions to complete. For each one there is a help button that enables the user to hear an audio file of the completed sentence.

This is the second of two activities that were designed exclusively for the phone. This type of word search game seems an ideal activity to be developed for the phone, as it is small, bite-sized, and can easily be completed by selecting letters in the grid using the 4-way navigation and select keys (you don't need access to the phone's alphanumeric keypad to key in the letters). The 'options' menu is required only for the instructions at the beginning of the activity. Within the questions, the simplified navigation system adopted for the Grammar quiz activity is used, as when you complete a question, you automatically move to the next question.

STUDENT EVALUATION OF THE PROTOTYPES

Following the initial design and development phase, the next step was to evaluate the prototypes with typical students to get their views of them. The evaluation sought to elicit feedback on a number of areas: the concept of mobile learning generally and specifically the mobile e-packs and their value for mobile language learning, the pedagogic approach taken and the type of activities produced, the design and usability of the activities, and to find out if they would use them, and if so, how.

An evaluation session was arranged, and attended by 8 students from the University taking an Intermediate French module. The session was recorded on video cameras to enable us to capture comments verbatim, and to attribute comments to individual students. The students were each given a Nokia N95 phone with the activities pre-installed and a set of headphones. They were given basic instructions on how to find and launch the activities on the phone (not in how to use the activities as this was one of the areas we wanted to test), and were asked to go through the activities in their own time. Afterwards, they each completed a questionnaire, and then took part in a focus group, which lasted about 50 minutes. The student group comprised 6 females and 2 males, aged between 18 and 35. 1 student was 18-20 (12.5%), 50% fell within the 21-25 age group and 37.5% were over 25 (considered to be mature students). They all rated their experience in using mobile phones as 'experienced' (62.5%) or 'very experienced' (37.5%) (they all owned a mobile phone of their own). All of them bar one had used the e-packs for the self-study component of this and other modules. Some of the responses from the evaluation session are presented in the remainder of this section, and focus on mobile learning and the mobile e-packs, design and usability, and the pedagogic approach taken.

Figure 3: Students taking part in the evaluation session

Mobile learning and the mobile e-packs

In the questionnaire, the students gave a very positive response towards mobile learning. They all said they would like the University to provide them with resources like this, and would be prepared to use their own mobile phone within their University course. To the question 'how useful would it be to access learning materials via your mobile?', on a scale of 1 to 5 where 1 is 'extremely important' and 5 is 'not at all important', 62.5% rated 1 and 37.5% rated 2 (no students had a neutral or negative view). Focusing specifically on the mobile e-packs now, the question 'how would you rate their usefulness in terms of learning a language' received a more mixed response: on a scale of 1 to 5 where 1 is 'extremely useful' and 5 is 'not at all useful', 25% rated 1, 37.5% rated 2, 25% rated 3 and 12.5% (1 student) rated 4. However, the majority had a positive view, and the responses to the question 'what did you think of the prototype mobile e-packs' help to explain these ratings (see Table 1).

Student 1: That it is a very good idea and people/students will be interested. However there are improvements that could be made on the whole. Yet students will be attracted to this idea because it gives us the opportunity to practice on-the-go and not at home by the computer.
Student 2: Interesting.
Student 3: It's good. Some could be improved, like for example being able to watch the video while reading the script at the same time.
Student 4: Very good.
Student 5: Overall, it was good. Some bits I liked more than others. The things I didn't like were the same things I didn't like about the Internet version. They are very similar.
Student 6: In my opinion they can be really useful, but I think it is important that all of the exercises have the 'help' choice.
Student 7: I found majority of them really useful. You can listen and at the same time read the examples that are being made. A few keep you on your toes while the others somehow confusing.
Student 8: It is very useful. Convenient.

Table 1: What did you think of the prototype mobile e-packs?

All the students thought that they were 'good', 'useful' or 'interesting'. Several thought that there was room for improvement which could account for some of the negative ratings given in the questionnaire. On the positive side, Student 1 thought they provide "the opportunity to practice on-the-go and not at home by the computer", whilst Student 8 thought that they were "convenient". The same question was asked at the beginning of the focus group, and some students elaborated on their answers. Student 1 said "they're handy", "they're useful", and thought they could save you time as you could use them on the bus to practice your French when there is nothing else to do. Student 3 made a similar comment and felt it was better to do them on the mobile rather than at home, because you can spend less time studying but still practise the same amount of grammar and vocabulary.

Focusing on issues to do with mobile learning rather than the pedagogy or content of the activities, what came out in the focus group about what they liked about the activities, is that they were "convenient", were easy to access "I think it's the access. It's easier. Almost everybody has got a mobile phone these days", and two mentioned that they were "easy to use". Comments about what they didn't like were mainly about the subject matter of a particular activity, except for one student who didn't like the fact that there wasn't a dictionary so you could look up words (in the e-packs there is a link to an online dictionary at the bottom of each activity).

Students offered a range of ways in which they thought that the learning experience of learning a language using mobile e-packs would be different, all of which were positive (see Table 2).

Student 1: I would do it more … because it's right there. It's... I mean I don't know about you guys but I can't live without my phone. It's my phone and it's my second heart. … Everything is with your phone …
Student 5: And sometimes people are on the computer but no-one's ever on your phone, so you've always got like your phone to do it. If you're waiting.... if you work and you study and you're doing a language, you're trying to get hold of the computer for a certain time period on a certain day, like, it's just a nightmare sometimes.
Student 1: Or the internet crashes. So we have so many problems with the internet … my phone's never crashed.
Student 5: But even if like, you're just waiting for your mate and they're 10 minutes late, that's like 10 minutes of work that you can deduct from how much you should be doing in the week and that's enough to get one of those games going. Do you know what I mean?
Student 4: Yeah, fitting it in somewhere, wherever you are really isn't it?
Student 5: It's just so convenient, like...
Student 1: … if you're on the underground and you can download it onto your phone, and you're waiting … it's not long enough time for you to take out your book and then sit there or you can't talk to your friends because there's no connection there.
Student 7: … it would be learning on the go … it complements the PC.
Student 1: I know so many people who would love to learn a language but they just don't have time, and with the e-packs [mobile e-packs] it gives them that opportunity to do it on the go, when they're on the bus, on the tube, whatever. And you know, I don't think people would have any problems with that.

Table 2: Extracts from student dialogue about the experience of mobile learning with mobile e-packs

The convenience of having learning activities on a mobile is seen to be beneficial, because your mobile is yours and it's with you all the time. Therefore, using the activities would not be dependent on having an internet connection, and they could be used whenever it was convenient, wherever you are, such as when you're waiting for someone/something or if you're travelling. As student 7 puts it, "learning on the go". This student also mentioned that the mobile e-packs would complement the ones on the PC, recognising that the mobile activities would not be a substitute for the e-packs, and would perform a different role, and that the mobile e-packs could be used in periods of dead time when there are not attractive alternatives.

Students were then probed into how they could picture themselves using the mobile e-packs (see Table 3).

Student 6: When you're waiting for something, then I think you would use it less at home …
Student 1: Or sometimes when you know you're bored or something, just waiting. For example, you're tired of doing one essay and you know, instead of logging into e-packs on the computer, you can still have your essay in front of you in case you get suddenly that spur of encouragement to ...
Student 5: It's just going away from the computer ... Chilling on the sofa with your phone.
Student 1: Exactly.
Student 8: And it's also good for example when you are going to bed, sometimes you cannot sleep for a while, you know, so you could just pick it up, or this morning for example I have a habit I don't want to get up at once, so it's like good to take it. This morning for example I read or something like that or listen to some music and it's good to pick up and do that stuff, yeah.
Student 1: It's like picking up a book, you pick up your phone and play French games and stuff, you know, while if it's on the computer you have to turn on your computer and you have to wait while it uploads and then you have to sign into your account. … On your phone it's like, flip it open or like, unlock it and da da da, you're there and then you play the games.
Student 5: It's true. Even at home someone else can be on the computer … but at least if you've got your phone you know you can still be doing something ...
Student 1: Like she said before, no-one's going to be using your phone ...
Student 4: I reckon I'd just use it travelling but I travel quite a lot. It takes up quite a lot of my day.
Student 3: On the way to work, while I'm waiting for someone, if someone's late, those kind of situations.

Table 3: Extracts from student dialogue about how they picture themselves using the mobile e-packs

However, they couldn't see themselves walking around whilst using the activities. Student 5 said: "I wouldn't but that's because I struggle with listening so like, I need to be able to see it and picture it. … So to walk down the street with somebody speaking French, it's just not going to, like, register. I would have to sit down and do it." Others commented that it's not like listening to music, you have to concentrate when learning, but that maybe simple activities, such as phrases to listen to and learn could be useful, but one commented that you would probably get bored with it. The concept of using the mobile phone to communicate with another student to carry out a role-play oral activity was also not embraced. Student 5 commented that this would hamper the convenience "because then we have to find mutual time …

the whole point of it being mobile is it's for you, when you want it". She thought that if you were going to arrange something together, why not "just meet up for a coffee and do it face to face anyway?".

Design and usability

Student feedback on the design and usability of the activities was of prime importance at this stage in the development process. Whilst the team had lots of experience in designing engaging and effective online activities, designing for the mobile phone was a new experience. The navigational systems adopted, the interface, and the design of activities for the smaller mobile screen were all areas where student feedback was required.

Students were observed whilst they were using the activities, and it is interesting to note that none of them asked for help in using the phone or in using the activities. In the questionnaire half thought the activities were 'very easy' to use and half 'easy' to use (none of them thought they weren't easy to use). Two students commented in the focus group when asked about what they thought about the mobile e-packs that they were easy to use.

In the questionnaire we asked them if they had any problems navigating through the activities, and if so what problems they had (see Table 4).

Student 1: No, I just found that when going through to the next question it felt a bit long having to go into options. It's OK however when wanting to listen to the question again.
Student 2: No
Student 3: When I tried to go to the next exercise in the videos, it didn't work and I had to quit and start again. Sometimes it seems like it freezes.
Student 4: Not really, sometimes the programme is slow to react to your commands.
Student 5: Navigation was fine.
Student 6: I had one problem. Took some time to realise in one of the 'games' that when I was making a mistake was always returning to the beginning.
Student 7: At first navigating wasn't easy, but I got the hang of it as I continued through the others.
Student 8: No, navigation is easy.

Table 4: Did you have any problems navigating through them?

Six of the students had no real problems. One said "navigation was fine", another "no, navigation is easy" and a third "at first navigating wasn't easy, but I got the hang of it as I continued through the others". Student 1 felt it took too long to have to go to 'options' to go to the next question, but this method was fine for wanting to listen to a question again. Of the 2 students who experienced problems, one of these was related to going to the next question in the activity that used video (the phone froze, which is a known problem with video and phone memory), and the other didn't realise in one of the games that when she made a mistake she was automatically taken back to the beginning. But none of the students actually reported problems using the navigational methods that were adopted. Further elaboration was given in the focus group. Student 5 said "it's really obvious what you're doing … you never have to go to somebody and, 'do you know how to do this'?", and Student 1 raised the point made in the questionnaire that she would prefer not to have to keep going to 'options' to go to the next question or page or to submit an answer, and that a solution could be to use the right 'soft key' which isn't used for anything, and could change functionality depending on which action is required on a screen. Several of the students confirmed that they found navigating "pretty easy" and that it was not confusing. Some specific issues with particular activities were mentioned but solutions were offered, such as giving more guidance and using simple icons or emoticons for question feedback rather than large pop-up boxes which stay on the screen for too long.

The scale of the activities on the mobile screen did not cause problems for any of the students. Comments were made that they were now used to doing a range of tasks on their mobiles every day, such as sending messages, reading emails, so that they were accustomed to the size of the screen and the content that was presented on it.

The visual design of the activities was also well received by the 7 students that gave a response on the questionnaire (see Table 5). All made positive comments, for example that they were "good", "nice to work with", "interesting", "clear", "nicely designed", with Student 5 commenting that they were "not as gimmicky and childlike at all (which I thought might be the case)".

Student 1: The appearance of the entire program was very well done, however it might be nice with some music, but then again some people can't work with music.
Student 3: It looks good, like the e-packs. However, some aspects could be improved. For instance, in the 'Bike exercise' when you get the question wrong the box that appears on the screen shows for too long.
Student 4: Good.
Student 5: Good. Clear, interesting. Not as gimmicky and childlike at all (which I thought might be the case).
Student 6: Really interesting. Nice to work with.
Student 7: They are mostly well laid out.

Student 8: Nicely designed. Looks very nice.

Table 5: What did you think about the look of the resources?

We didn't specifically ask students what they thought about the multimedia and interactive aspects of the activities, as these are key features of the e-packs anyway. However, Student 5 said of the use of multimedia, "Reading sends you to sleep but this has got like moving images. It keeps you engaged, it's not just like reading transcript after transcript. It's like, you can listen or you can read or you can watch or you can play. So it keeps you engaged the whole time." Student 6 said that she particularly liked activities that were like playing games.

Pedagogic approach

Most of the comments about the pedagogic approach taken were made during the focus group, and in relation to specific activities.

The Vocabulary activity about the bike received a mixed response from students. Students 2 and 6 liked this activity the least, whilst Students 1 and 5 liked the activity but not the subject matter, and most of the negative comments made related to this aspect, rather than the type of activity itself. The main problem was that they didn't have the required vocabulary or the interest in the subject matter for it to be of interest to them, summed up by Student 1: "I liked the bike as well but it was … the content I didn't like so much. You know like, as [name of student] said, it was probably better you know, with a room or something or you know, the body, something that you know. You know, something that could be useful." Some students commented that they didn't like the large pop-up boxes when you got one wrong.

The Grammar Quiz activity was liked the most by Student 2 and liked the least by Student 1. Student 5 was disappointed, as she likes quiz type activities and thought she'd like this the most but didn't like it (she chose to do this one first on the phone). The main criticisms were not with the type of activity, but relating to the fact that if you get a question wrong, you have to go back to question 1 and do all the other questions again. As Student 5 said, "it's so repetitive that you have to keep doing the same questions. You just want to switch off and go onto something else.". However, students discussed other methods for completing the activity, such as having 3 chances to get questions right before going back to the beginning.

The Video True/false activity received few comments, and no students chose it as the activity they liked or disliked the most. Student 3 said "I liked the video exercise because you can actually hear the intonation. … And if you want to learn the right accents or pronunciation, for me it's very useful". Student 5 said that she liked the conversational nature of the video, and that she could get a sense of the way young people would speak and the words that they would use in this situation, which was a contrast to learning perfect grammar. The only negative comment on this activity came from Student 1, who didn't like the pop-up boxes giving feedback when you got the wrong answer, because they appeared on the screen for too long.

The Grammar Presentation activity was the activity liked the most by 6 of the students. The initial dialogue between the teacher and the student was particularly well received. Student 7 said she particularly liked it because she could listen and read about the verbs, without having to go and find a book or a dictionary. Student 5 responded "That was my favourite one as well, just because it's listening but you can see it written, like for me to hear a word and to see it, I can link it better". For her, the combination of dialogue to listen to and text to read on the screen helped her to learn the concept more easily. Student 2 liked the way that things were explained, and Student 4 also thought the explanations were good. Student 8 liked the grammar one best "because it was useful" and you didn't need to write notes, because it was all there in the activity for you. The only negative point was made by Student 5 who commented that it would be useful to be able to pause the audio commentary if you wanted to concentrate on the text on the screen for longer. The 'word order' sentences which appeared after the dialogue however, were subject to mixed views from the students. Student 3 found them boring. Several students commented that they were a bit difficult, partly because there were a lot of words to put in order, and that you didn't get much guidance if you got it wrong. A particular criticism was that if you made a mistake and realised later on, you couldn't go back and correct it, without submitting it and attempting it again from scratch. Student 4 found it quite difficult, but recognised that it's a good exercise and is teaching things that are useful to know, and would like more guidance. Students 5 and 6 however, liked the fact that you had to try and complete each sentence within a set time-frame (a minute). Student 5 liked the fact that it made you "think really quickly on your feet", and it was good practise for the exam in getting you used to time pressures. Student 6 said "it makes me a little bit nervous because of the time, but it's like, challenging", agreeing it's a bit like a game.

The Vocabulary Search activity received quite a lot of negative views. It was liked the least by 3 students. Student 5 disliked it for a number of reasons, that you might know the word you are looking for but not how to spell it (she'd like a dictionary to be able to refer to), or would like more responsive feedback so if you've gone beyond a certain number of incorrect letters, you know. She said "I felt it was really abstract", just looking for words. Student 7 found it "a bit confusing", because she didn't know in which directions to look for the words, and complained that once you'd selected a letter you couldn't unselect it. Student 1 found it frustrating if you listened to the audio and you couldn't make out the one word you needed to complete the activity.

CONCLUSIONS

The design of these first prototypes has raised a number of pedagogical and technical issues in determining how existing activities can be transferred to the mobile phone, and in considering what kinds of pedagogic approaches and activities are most appropriate for mobile learning. The student evaluation was arranged to test our design assumptions at this early stage, to determine if we are taking approaches that students agree with. Some aspects have been well received, and others haven't, but the overall response from the students is very positive (towards mobile language learning and mobile learning in general). Their feedback is very valuable at this stage, and they have given numerous suggestions for how the activities could be improved, many of which will be taken into account in the next stage of development. We acknowledge that this evaluation has been small in scale, and that we will need to carry out more extensive testing on some of the issues that were raised.

One of the key messages to come out of the evaluation was that these students were very conscious of the demands on their time, for this and other modules. They suggested that m-learning is a more convenient way to learn. They could make use of any periods of dead time to practise their French and in doing so reduce the rest of the time they need to spend on this task during the week. Having mobile activities could therefore save them time, being able to practise whilst they're travelling on the bus or the underground, waiting for friends, or relaxing before going to sleep or getting up in the morning. Small activities, such as those developed for the mobile e-packs, can be used whenever there are short periods of time available. There were other advantages too, such as not always being able to get access to a PC and/or the Internet, and that because your phone is your own and always with you, it's more convenient. Some students also commented that the mobile e-packs keep you engaged, because many of the activities are game-based and quick and easy to complete.

There is a need to do more research around the potential for mobile learning for languages beyond the content development of activities (even though they have a role to play). Kukulska-Hume and Traxler (2007) identify a number of emerging categories of m-learning initiatives: the ones that are technology driven where learning is secondary to technology, the ones that support 'connected classroom learning' and which rely on classroom pedagogy and finally the most innovative ones that are used to encourage personalised, situated and informal learning. This is also supported by Patten, Arnedillo, Sanchez and Tangney (2006) who call for an approach to m-learning which encourages collaborative, contextual and constructivist learning in authentic environments.

However, we see these multimedia mobile language activities complementing PC-based online activities and classroom teaching within a blended learning framework. Where we need to continue our work, is in the underlying pedagogic approach to the activities, refining their design, and conducting further exploration into the type of activities that are most effective for mobile learning or 'learning-on-the-go' as one of the students called it.

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Useful web resources for developing Flash Lite applications:

Adobe Device Central User Guide. Available from: http://livedocs.adobe.com/en_US/DeviceCentral/1.1/index.html

Boston Adobe Mobile and Devices User Group website: Available at: http://www.flashmobilegroup.org/

Flash Devices website. A Flash development resource for non-PC devices. Available at: http://www.flashdevices.net/

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MobilED: A Step Backwards to Look Ahead

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ABSTRACT
MobilED started as an international collaborative project to facilitate and support teaching and learning through the creation and support of learning environments using mobile technology. This paper provides an overview of the theoretical underpinning and reflects on the project methodology. We discuss and analyse what worked and what didn't work. Problems encountered such as navigation and entry to schools with set curricula and limited time are articulated and some contextualised recommendations are made.

Author Keywords
IT – Information Technology, Semi-summative assessment, Audio-wiki, Reflective practitioners, Design research, Formative assessment, Text-to-speech, Speech Synthesizer, IVR – Interactive Voice Response, DTMF – Dual Tone Multi Frequency.

INTRODUCTION

The rapid technological advances in the field of technology development and the widespread integration of the device in social and cultural practices (Kress & Pachler, 2007), has created unique opportunities for educators, researchers and practitioners. Mobile learning has developed from a few small scale pilots to a set of significant projects in schools, workplaces, museums, cities and rural areas around the world (Sharples, Sánchez, Milrad, & Vavoula, 2007).

Contrary to trends in the developed world, where the PC and Internet-connectivity is almost ubiquitous, mobile phones are currently the most important networked knowledge exchange technology used in the developing world. From a developing country perspective, features such as limited or no dependence on permanent electricity supply, easy maintenance, easy to use audio and text interfaces and the affordability of these devices are critical. While the African reality presents well documented limitations (Abungu, 2002; Akinboade & Lalthapersad-Pillay, 2005; Czerniewicz, 2004; Ford & Whaley, 2003; Klein, 1993; Nwauche, 2005; Traxler & Leach, 2006) it also records a rapidly growing mobile cellular growth rate. According to the International Telecommunications Union, African mobile cellular growth rate has been the highest of any region over the past 5 years, averaging close to 60% year on year with a recorded figure of 76 million users on the African continent at the end of 2004. Joel Selanikio the co-founder of DataDyne states:

…this revolution of personally-financed wirelessly-connected computers largely goes unnoticed by the international development community, and because their paradigm revolves around desktops and laptops they spend millions developing specialized laptops for school children in developing countries, which will surely only ever reach a small fraction of them, while the network of invisible computers continues its exponential penetration into those same regions, below the radar(Selanikio, 2008).

MobilED (Mobile Education) (2005) started as an international collaborative project that consisted of collaboration between, the South African Meraka Institute of the CSIR, University of Pretoria, Tswane University of Technology and the University of Pretoria, and international partners, including the Media Lab of University of Art and Design Helsinki (Finland), Escola do Futuro Universidade de São Paulo (Brazil) and the WikiMedia Foundation (United States).

In the absence of desktop computers and ubiquitous internet access, MobilED endeavours to research alternative access to the information age so as to prepare learners for full participation in the knowledge society. Within the initiative there is an acknowledgement that a new approach or model to integrating technology into the classroom is needed for developing regions. The initiative strives firstly to contribute to scientific and technical knowledge on how groups of young people are using mobile devices in everyday knowledge sharing and problem-solving situations, both in the developed and developing worlds. A secondary purpose is to develop a suite of technology platforms to support the use of mobile technology in education. This includes developing research-based models and scenarios of how mobile phones could be used for teaching, learning and empowerment of students within and outside the school context.

METHODOLOGY

Reeves, Herrington and Oliver (2005, p.96) recommends design research as a particularly appropriate approach to socially responsible inquiry. Van den Akker (1999) describes design research as:

…more than most other research approaches, development research aims at making both practical and scientific contributions. In the search for innovative 'solutions' for educational problems, interaction with practitioners… is essential. The ultimate aim is not to test whether theory, when applied to practice, is a good predictor of events…(but) is it possible to create a practical and effective intervention for an existing problem or intended change in the real world?(p.8-9)

Several significant development iterations were planned. The first of these iterations was the development, implementation and evaluation of a mobile audio-wiki. The study was based on a "pragmatic epistemology that regards learning theory as being collaboratively shaped by researchers and practitioners" (Reeves, 2000) with the overall goal of enabling participation in the knowledge society. This participation was aimed at lower end mobile phone users, giving them access to information on the Internet while simultaneously constructing "design principles" which can inform future iterations. This paper reflects on the lessons learnt and insight gained.

THEORETICAL UNDERPINNING

Garcia and Quek point to the difficulty of defining the actual object of information technology systems research " *Is the object of research in information systems of a technological or social nature? (Garcia & Quek, 1997, p.450)"*. One of the problems we faced in the project was to develop a common understanding and vocabulary between the researchers, practitioners and the development team. The research encompasses two disciplines, Information Technology Research (engineering endeavour) and Educational Research (social endeavour). The development and feedback from one domain would influence and report success in the other. There is thus a trans-discipline interaction that needed to be navigated in order to achieve the desired results. The research needed to acknowledge the existence of two worlds, an intransitive world (natural) in which the engineering endeavour would take place, and a transitive world where the social endeavour would take placed and is social and historical (Bhaskar, 1991; Dobson, 2002). Gamache (2002) states that "a*ll practice is rooted in some theoretical framework, if not explicitly, then implicitly. Since methods are based upon epistemology, and epistemology is based on ontology, educational practice is never value-free."* As we approached the research project with differing epistemological and ontological perspectives, it became apparent to us, as a research team, that we needed a common underpinning. This research was thus approached from a critical realist perspective, providing a basis for bridging the dualism between subjective and objective views as *"real objects are subject to value-laden observation (Dobson, 2002)"*

The philosophical considerations in this research was thus to be the common ground for practitioners in both domains. From a critical realist view our research acknowledges that

> *…there is no conflict between seeing scientific views as being about objectively given real words, and understanding our beliefs about them as subject to all kinds of historical and other determinations.(Norris, 1999)*

METHODOLOGY

Plomp (2006) defines educational design research as the systematic study of designing, developing and evaluating educational interventions as solutions for complex problems in educational practice. Reeves (2000) states that "*researchers with development goals are focused on the dual objective of developing creative approaches to solving human teaching and learning, and performance problems while at the same time constructing a body of design principles that can guide future development efforts.(p.7)"* These correlate with the MobilED technical and developmental objectives:

- Explore and comprehend the cultural, social and organizational context of young people in and out of in their use of mobile phones.
- Develop research-based models and scenarios of how mobile phones could be used for teaching, learning and empowerment of students within and outside the school context.
- Develop concepts, prototypes and platforms that will facilitate and support the models and scenarios developed.
- Test, evaluate and disseminate the scenarios, models, concepts, prototypes and platforms in the four countries

Each phase of the study covers four main phases (Mc Kenney, Nieveen, & Van den Akker, 2006; Nieveen, Mc Kenney, & Van den Akker, 2006; Plomp, 2006; Richey, Klein, & Nelson, 1996), adapted from the model used by Mc Kenney (2001). These stages have been tailored to the study and are: Needs and context analysis, prototyping stage and assessment and systematic reflection.

Nature of conclusions

Where instructional development typically builds on previous research, developmental research, in contrast, attempts to produce the models and principals that guide the design, development and evaluation processes (Richey et al., 1996). Development research is regarded as having a dual focus (Richey et al., 1996; Van den Akker & Plomp, 1993), delivering:

- ***Design principles***. Plomp (2006) refers to this as intervention theory while diSessa et al.(2004) calls it ontological innovations, Cobb et al.(2001) domain specific theories and Van den Akker (1999) heuristics.
- ***Prototypical product.***

The conclusions are generated in context and include the conditions that promote successful use of the product and its impact (Richey et al., 1996).

REFLECTION ON METHODOLOGY FOLLOWED

The first stage of the initiative was centred on the development of an audio-wiki for the remote access and retrieval of reference material and information. We decided to investigate the use of low-cost mobile phones which are readily available in Africa.

Preliminary Research

The research around the audio-wiki was driven by researchers from the University of Art and Design in Helsinki and the University of Helsinki. The purpose was to establish the pedagogical underpinning of the technology solution and how it should be constructed in an application and lesson. The audio-wiki intervention was conceptualised and envisaged to support the following:

- Student and group-centred learning
- Project-based learning
- Problem solving
- Inquiry learning

The University of Art and Design in Helsinki developed an audio-visual mock-up of a scenario where the typical use of this potential service was mimicked. This audio-visual was shown to the technical team and followed by a workshop with the researchers that initially conceptualised the idea. From the meeting and the audio-visual, the design team extracted the requirements that related to technical functionality.

Prototyping

Two pilots were convened at two schools with approximately 120 learners being involved. A researcher from the University of Art and Design in Helsinki, was the main facilitator during the first pilot and was assisted by the two "reflective practitioners" (Reeves, 2006) from the University of Pretoria that were also educators of the particular groups of students at the time. The second pilot was undertaken at another school where a Meraka researcher and the same two researchers from the University of Pretoria, assisted one of the educators at the particular school to facilitate the lesson. During these pilots the students' use of the service was monitored and technical problems or difficulties were captured. Interviews were conducted with students, educators and the facilitators, before, during and after each session to facilitate formative assessment (Plomp, 2006).

For the first pilot a complete version of the audio-wiki development was undertaken and piloted in one school. The audio-wiki application allows the learner to use the standard text messaging capability of the mobile phone (SMS) to request an article from the MobilED platform. This is done by entering a key word relating to the topic of interest, and sending the message to the phone number assigned to the MobilED platform. The service calls the user, and starts reading the Wikipedia article from the top, using interactive voice response (IVR) and text-to-speech (TTS) technologies. It reads the article to the user using a synthesised (computer-generated) voice in combination with pre-recorded voice prompts, and accepts input from the user via DTMF (Dual Tone Multi Frequency)/Touchtone key presses. Each article is broken up into sections (it uses the sections as they appear in the Wikipedia article) in order for the service to allow the user to navigate through the article or between related articles.

Figure 1. Send SMS with search term to MobilED number.

A user also had the opportunity to contribute information to the information source (local Media-Wiki server) by recording his/her voice over the telephone and adding it to an existing article.

Figure 2. A user can make a voice recording with the mobile phone and add it to an article.

A second pilot was convened at another school. The results of the first pilot were used as feedback to refine the development for implementation in the next development iteration. Various feedback functionalities were added and the navigation interface was refined.

Assessment

Semi-summative assessment (Nieveen et al., 2006) was conducted after the conclusion of the second pilot. The write-up consisted of two masters' studies at the University of Pretoria (Batchelor, 2006; Botha, 2006) and approximately ten conference articles that were accepted for publication.

EVALUATION

The project team tried to be very critical of the whole process in order to establish a feasible methodology for this kind of project development in future. This section focuses on what worked and what didn't work.

The preliminary research was strongly based on computer, technology and mobile use in the developed world and carried primarily euro centric ideas and views. One of the reasons for this was due to the fact that so little was published regarding the use of mobile technology in learning environments in the developing world. This part of the research was also mainly conducted by the Finish partners, who at that stage had a limited understanding of the South African context.

The South African researchers only started with research in this field at the time and were not in a good position to qualify the validity of applying research findings of the developed world in this context.

We believe that the South African context is very different to that of the typical developed or developing worlds. On the one side, the general public, including learners from a more disadvantaged background, is very used to mobile technology. They either own mobile phones themselves or have access to it, making them very aware of the functionalities and possibilities provided by this technology. This degree of comfort with the technology was not necessarily expected by the researchers, although it became quite clear over the last view years. On the other hand, the South African public uses mobile phone technology mostly for personal communications and was not very used to the value added services that are typically provided by governments and the service industries in developed countries. This kind of value added services are mostly information based and often makes use of synthesised voices to convey the information via speech over the communication line (mobile or fixed line). Since the audio-wiki application relies on a text-to-speech converter to deliver Wikipedia information via a synthesised voice, this was something that would definitely have a big influence on the acceptability of such a service.

Although the audio-visual mock-up captured many of the activities that the technology was expected to support, finer nuances of the interface and technical specification was left hanging and open to interpretation by the developers. This open ended brief caused uncertainty within the technical design team and caused conflicting expectations.

Access to schools can be very challenging as curricula are in place and needs to be adhered to and limited time is given to each subject. Furthermore the position of educator as final decision maker in a classroom is what eventually determines the possibility or success of any intervention. The technical team envisaged this pilot more as a testing phase of the technology than an actual pilot. As we piloted with immature technology, the educators expressed frustration at what they perceived as a lack of planning. The technical team was surprised by this reaction of the educators and we realised that the educators, developers and researchers had very different expectations of the pilot.

Implicit expectations, whether culturally biased or domain specific, were never formally addressed. In the long term, this caused a break down in communication due to misunderstandings. This was further compounded by the physical distance between initiative members as the research was mainly driven by the Finish partners and the development by the Meraka Institute.

RECOMENDATIONS

When working across two domains, the needs and expectations inherent in the disciplines should never be underestimated and needs to be accommodated. There is a very real need for practitioners that has a grasp on both domains to facilitate discussion and act as interpreters between the different worlds. Implicit expectations and agendas need to be explicitly stated and bought into. This kind of project requires a different perspective to what either domain are comfortable with working in and flexibility is needed to accommodate each others perceptions. One should however not confuse flexibility with informal working procedures. The need for establishing commonality increases exponentially as project partners are physically distanced from one another, limiting face to face communication. It is important for the design team to develop a common language and understanding, grounded in models of best practice and formalised agreements, articulating expectations from all participants.

It is not recommended to use preciously gained entrance to an education institution for initial piloting of a prototype. Smaller iterations with a limited group of representative individuals and critical colleagues should be used for initial piloting and feedback. In this way, the sanctity of the classroom is respected as the educator can utilise the technology when it suits them in a further iteration with more stable technology. Ideally this educator should form part of the initial discussion and pilot group. In this way, very applicable and practical feedback in terms of requirements can be expected during the preliminary development and piloting. Ownership is critical to sustainable development and implementation and therefore the educators' participation should never be underestimated.

Planning and initial research need to be strongly contextualised in localised conditions. Assumptions of research findings in different contexts should be carefully scrutinised and tested for transferability and relevance.

CONCLUSIONS

Navigating a project of this nature and planning for it is completely different. When reflecting on this initiative as an iteration of a much larger whole, it is important for all concerned parties to learn from experiences gained. These experiences are often tacit knowledge and taken for granted, failing to be incorporated in subsequent initiatives. This paper aims to articulate and share lessons learnt that are easily avoidable when anticipated.

It is very important for all individuals and teams that are involved in mobile learning projects to take cognisance of the relatively sensitive environment in education, where buy-inn from educators would increase the success of the pilot and the possibility of sustainable future relationships.

Mobile technology projects seem to enhance all these considerations because of the personal nature of the technology as it is integrated in the cultural praxis to a larger degree. Technology is and can never be value free and as such, these values need to be articulated and agreed upon by all members of the project team. It is hoped that practitioners and project managers are able to transfer some of our findings to their own initiatives.

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Challenges in Evaluating Mobile Learning

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ABSTRACT
We propose six challenges in evaluating mobile learning: capturing and analysing learning in context and across contexts, measuring mobile learning processes and outcomes, respecting learner/participant privacy, assessing mobile technology utility and usability, considering the wider organisational and socio-cultural context of learning, and assessing in/formality. A three-level framework for evaluating mobile learning is presented, comprising a micro level concerned with usability, a meso level concerned with the learning experience, and a macro level concerned with integration within existing educational and organisational contexts. The paper concludes with a discussion of how the framework meets the evaluation challenges and with suggestions for further extensions.

Author Keywords
Mobile learning evaluation; learning context; evaluation framework.

INTRODUCTION
Mobile learning is a relatively new research area, with the first research projects appearing in the second half of the 1990s and the first international research conferences less than a decade ago. It is a field whose practice has not been standardised yet in terms of research frameworks, methods and tools. Thankfully, mobile learning has a lot of common ground with other research areas including technology-enhanced learning and Mobile Human-Computer Interaction (mobileHCI). 'Borrowing' frameworks and techniques from these areas has been common practice for early mobile learning research, and has indeed provided researchers with useful starting points.

As our conceptions and understanding of mobile learning deepen, these 'borrowed' frameworks and tools might no longer be adequate. We now appreciate mobile learning not just as learning that is facilitated by mobile technology, but also as the processes of coming to know through conversations and explorations across multiple contexts amongst people and personal interactive technologies (Sharples et al. 2007b). Such evolving conceptions introduce numerous challenges to all aspects of mobile learning research, including evaluation. As the field matures, our frameworks and tools need to respond to these challenges.

In this paper we summarise six challenges in evaluating mobile learning: capturing and analysing learning in context and across contexts, measuring the processes and outcomes of mobile learning, respecting learner/participant privacy, assessing mobile technology utility and usability, considering the wider organisational and socio-cultural context of learning, and assessing in/formality. The paper proposes an evaluation framework with three levels: a micro level concerned with usability, a meso level concerned with the learning experience, and a macro level concerned with integration within existing educational and organisational contexts. The paper concludes with a discussion of how the framework meets the evaluation challenges and with suggestions for further extensions.

CHALLENGE 1: CAPTURING LEARNING CONTEXT AND LEARNING ACROSS CONTEXTS
A major task for educational evaluation is to capture and analyse learning in context. For mobile learning, the interest is not only in how learning occurs in a variety of settings, but also how people create new contexts for learning through their interactions and how they progress learning across contexts. This poses a significant challenge to evaluators of mobile learning. To appreciate the challenge, let us compare mobile learning contexts with traditional classroom contexts from the researcher's perspective. In order to establish and document the learning context, the researcher needs to know: the location of learning and the layout of the space (where); the social setting (who, with whom, from whom); the learning objectives and outcomes (why and what); the learning method(s) and activities (how); and the learning tools (how).

In a traditional classroom, researchers generally have access to information about these context elements before, during and after the learning experience. For example, they can approach the teacher and learners in advance of a lesson to find out about objectives, methods, or tools; or they can visit the location beforehand. For mobile and informal learning, however, even the learners may not know this information in advance. Learning objectives, for example, may develop on-the-fly as a response to interactions with the environment. The learners themselves may not be known in advance as is the case, for example, when evaluating general museum visitors' learning. If the evaluation is not confined to a specific learning site (e.g. a museum or work environment), the location, space layout and social settings can be unpredictable. Table 8 below portrays this increased vagueness as we move from the classroom to a school museum visit, to general museum visits, to everyday mobile, informal learning contexts. This increased vagueness has implications on the design of the evaluation in terms of data collection and analysis.

-- _______________________________vagueness_______________________________ ++

	Classroom	**School museum visit**	**…**	**General museum visit**	**Mobile**
Location and space layout	☑ fixed	☑ but not standard		☑ but not standard	☒ unpredictable
Social setting	☑ fixed	☑ but not fixed		☒ unpredictable	☒ unpredictable
Learning objectives and outcomes	☑ pre-set, external	☑ pre-set, external		☒ unknown	☒ unknown
Learning method and activities	☑ pre-determined	☑ pre-determined		☒ unknown – maybe some idea	☒ unknown
Learning tools	☑ fixed	☑ fixed		☒ unpredictable	☒ unpredictable

Table 8. Context elements discernible to the learning researcher: vagueness of context increases as we move away from the classroom into more informal, mobile situations.

Recent research efforts have focused on devising tools and methods appropriate for capturing and analysing mobile learning contexts. Some efforts concentrate on implementing technology-based solutions for data collection, such as mobile eye tracking (Wessel et al. 2007) or wearable interaction capture kits (Roto et al. 2004). Although such technical solutions have the advantage of capturing accurate data in context, they have some disadvantages, not least the obtrusiveness of the apparatus used. Other efforts opt for approach-based solutions, such as using learners' accounts of the experience through retrospective interviews, diaries, or attitude surveys (Vavoula 2005; Clough & Jones 2006), although these come with their own shortcomings such as the accuracy of recall, the degree to which post-rationalisation skews data, and the effect of the participants' concern over the image they project. Increasingly, mobile evaluation designs include mixed methods. These are useful not only for validating data, but also for capturing different perspectives of the learning experience. Thus, collected data might include recorded video, audio transcripts, observation notes, artefacts produced by the learners, application screenshots, etc. Interpreting such rich collections of data can be challenging too, in terms of assembling it into a meaningful, accurate and elaborate account of the learning experience. Related research addresses the design of tools and methods to support the sequencing, inter-relation and visualisation of evaluation data (Papadimitriou et al. 2007; Smith et al. 2007).

CHALLENGE 2: HAS ANYONE LEARNED ANYTHING?

A second challenge that faces mobile learning evaluation is the assessment of learning processes and outcomes. In traditional learning settings such as the classroom there are well-established and accepted methods for the assessment of learning activities, such as essay writing, multiple choice tests, open-book exams, and unseen examinations. Distinctions have been made between formative assessment (aiming to provide students with feedback regarding their progress) and summative assessment (aiming to judge and sum up the students' achievements) (Scriven 1967), with formative assessment bearing the greater potential to aid and complement teaching and learning (Black & Wiliam 1998a; b). Summative assessment is often used as a measure of success of the teaching as well as a measure of effectiveness of the learning (Boud 1995), but with many (often unresolved) issues regarding the reliability and validity of summative assessment methods (see Knight 2001 for a discussion of these issues). Despite these difficulties, summative assessment can be meaningful in formal learning contexts where learning objectives and desired outcomes are well specified in advance. By contrast with formal education, mobile, informal learning can be both personal and elusive. The learning may be personally initiated and structured, such that it is not possible to determine in advance where the learning may occur, nor how it progresses or what outcomes it produces. It may also be difficult to track the progress of learning if it occurs across multiple settings and technologies.

Instead, suggestions have been put forward to examine the experience for evidence which might suggest that productive learning is taking place. For example, in the context of museum learning, Griffin and Symington (1998) suggest to watch for instances where learners show responsibility for and initiate their own learning (e.g. by writing, drawing, or taking photos by choice; deciding where and when to move), are actively involved in learning (e.g. by absorbed, close examination of resources; or persevering with a task), make links and transfer ideas and skills (e.g. by comparing evidence), and share learning with experts and peers (e.g. by talking and gesturing; or asking each other questions). One method to do this is to videotape the activities of learners who wear radio microphones and are observed by a video-camera at a discrete distance. The evaluators then watch the videotapes to identify observable critical incidents that appear to be breakthroughs (indicating productive new forms of learning or important conceptual change) or breakdowns (where a learner is struggling with the technology, is asking for help, or appears to be labouring under a clear misunderstanding). These incidents can be assembled into a compilation tape and reviewed with the learners. The problem of assessing learning across multiple settings can be addressed in part by evaluating a combination of log files of computer activity or web access to show activity, outcomes such the results of online quizzes and media created by the learners, and personal reflective documents such as blogs and e-portfolios. Further work is needed to integrate these into a revealing and valid assessment of learning.

The challenge of assessing learning is not unique to mobile learning and does not afford an easy fix. Although a learning experience can be a well defined event with a start and a finish, learning is an ongoing, lifelong process of personal transformation and, as such, requires longitudinal, historical assessment.

CHALLENGE 3: AN ETHICAL QUESTION

Mobile learning can involve the use of mobile technology, which may also be personal technology. Tapping into a person's mobile phone to find out how they have been using it to learn might mean invading that person's privacy. Although research ethics frameworks are implemented by most research institutions and organisations, mobile learning research raises profound ethical issues.

The extent to which learners are willing to be monitored and the extent to which they will be ready to let the evaluators into their private lives is one particular concern. Obtaining informed consent can be problematic: the previous sections described the vagueness of mobile learning context and the elusiveness of mobile learning outcomes. When evaluators are uncertain of what will constitute the mobile learning experience, how accurately can they inform the participants of what data is sought and why? Assuming that a vague description of the requirements for participations is acceptable, how can learners consent to disclosing information about events they currently do not know when, where and under what circumstances will take place?

Even if the essence of the evaluation is successfully conveyed to the participants, and they consent to it, there are still important issues to consider relating to the degree to which they will co-operate in practice – either in terms of disclosing *all* that might be relevant, or in terms of carrying out related practical tasks such as synchronising their mobile devices as and when requested (Trinder et al. 2007).

A major challenge then for mobile learning evaluation is to accurately inform participants and to ease their participation in practice. In the process it will be worth for the evaluator to ask themselves how much they really need to know, and to investigate best practices in safeguarding and disseminating sensitive personal data.

CHALLENGE 4: LET'S NOT FORGET THE TECHNOLOGY

Evaluations of mobile learning often reference inherent limitations of mobile devices, such as their small screens, short battery lives, intermittent connectivity, and associated human factors, all of which affect their usability. As the focus of research shifts from the mobility of the technology to the mobility of the learner, additional issues arise as learners move across multiple devices, possibly over short time periods in multiple locations. Assessing the usability of the mobile technology and the effectiveness of its integration with the mobile learning practice remains a high priority for evaluation.

Thus, mobile HCI challenges stemming from the complexity introduced by physical movement and changing variables (Kjeldskov & Stage 2004) and the small scale and ubiquitous nature of mobile devices (Hagen et al. 2005), add to the challenges already facing mobile learning evaluation.

CHALLENGE 5: SEEING THE BIGGER PICTURE

Oliver and Harvey (2002) suggest four different kinds of impact of educational technologies in Higher Education (HE): impact on students' learning, impact on individual academics' practice, impact on institution, and national impact. In the same context of HE Price and Oliver (2007) identify three types of impact studies: anticipatory, ongoing and achieved. Anticipatory studies relate to pre-intervention intentions, opinions and attitudes; ongoing studies focus on analysing processes of integration; and achieved studies are summative studies of technology no longer 'novel'. Riley (2007) extends this impact framework by distinguishing between minor modifications and culturally significant changes in practice, and suggesting that different kinds of change will emerge over different timescales.

Although not exclusively linked with HE contexts, mobile learning evaluation has similar questions to answer regarding impact. It needs to consider the relation between personal and institutional learning. It needs to look at the immediate learner experience, the processes of integrating emerging with existing practices, and the implications that manifest after full deployment. These requirements necessitate an extended view of learning context to include not only the learner's personal context but also the changing socio-cultural and organisational contexts of the mobile learning experience; and also an extended view of the role of evaluation as a continual process of adjustment and fine-tuning.

CHALLENGE 6: FORMAL OR INFORMAL?

Mobile learning is often defined in terms of the technology that mediates the learning experience: if the technology is mobile, so is the learning. Mobility, however, is not an exclusive property of the technology, it also resides in the lifestyle of the learner, who in the course of everyday life moves from one context to another, switching locations, social groups, technologies and topics; and learning often takes place inconspicuously or is crammed in the short gaps between these transitions. Although this view of learning is inclusive of formal education contexts, it is particularly pertinent to everyday, informal learning.

Nevertheless, characterising a learning experience as formal or informal can be complicated. For example, is the learning of pupils visiting a museum (largely considered an informal learning setting) with their school (an irrefutably formal learning setting) a case of formal or informal learning? There is a large literature related to definitions of informal learning and related terminology, a review of which is beyond the scope of this paper; however, a general tendency seems to be to define informal learning in contrast to formal learning, and formal learning in turn to be confined to learning that takes place in educational settings. Colley and colleagues (2003) argue that "seeing informal and formal learning as fundamentally separate results in stereotyping and a tendency for the advocates of one to see only the weaknesses of the other … It is more sensible to see attributes of informality and formality as present in all learning situations". They advocate four groups of attributes: those related to the learning process, to the location/setting, to the learning purposes and to the learning content; and propose that attributes of in/formality are interrelated in different ways in different learning situations, and that those attributes and their interrelationships influence the nature and effectiveness of learning in any situation.

Understanding such attributes of in/formality and their interrelationships in mobile learning is important for evaluation, as it is not only a case of analysing pre-existing practices in terms of processes, settings, purposes and content, but also a case of capturing how the introduction of, or new way of supporting, mobile learning practices changes the in/formality of the learning experience.

REQUIREMENTS FOR MOBILE LEARNING EVALUATION

The challenges discussed in the previous sections indicate that mobile learning evaluation needs to:

- Capture and analyse learning in context with consideration of learner privacy
- Assess the usability of the technology and how it affects the learning experience
- Look beyond measurable cognitive gains into changes in the learning process and practice
- Consider organisational issues in the adoption of mobile learning practice and its integration with existing practices and understand how this integration affects attributes of in/formality
- Span the lifecycle of the mobile learning innovation that is evaluated, from conception to full deployment and beyond

A THREE-LEVEL FRAMEWORK FOR EVALUATING MOBILE LEARNING

To illustrate how the above requirements might guide evaluation in practice, this section will summarise an evaluation framework for mobile learning and its application in the context of supporting students' mobile learning when they visit a museum with their school.

The framework was developed in the context of the Myartspace project, which was an attempt to support structured inquiry learning through the design of an integrated technology that connects learning in the classroom with learning in museums and galleries. Detailed descriptions of the project and the evaluation process and outcomes have been presented elsewhere (Vavoula et al. 2006a; Vavoula et al. 2006b; Sharples et al. 2007a; Vavoula et al. 2007). In summary, Myartspace addresses the problem of how to connect activities on a museum trip to planning and further study in the classroom. It enables users to create their own interpretations of museum objects through descriptions, images and sounds they collect at the museum and then further research, reflect upon and share outside the museum. Before the visit, the teacher will typically set an open-ended question that the students can answer by gathering and selecting evidence from the museum visit. On arrival at the museum, students are given multimedia mobile phones which they can use to 'collect' exhibits, take photos, record sounds, or write text comments. This content is transmitted by the phone to their personal online collection which, back at school, the students can organize into personal galleries to present their findings in the classroom and share with their friends and family. Evaluations showed that the service was effective in enabling students to create multimedia evidence from enquiry-led learning in the museum, which provided resources for effective construction and reflection in the classroom. Minor usability problems did not detract from the learning, however there are significant issues concerning how to structure the museum visit and on the viability of Myartspace as a regular museum service.

The evaluation framework of Myartspace consisted of three levels:

1. Micro level: the micro level examines the individual activities of the technology users and assesses usability and utility. In the case of Myartspace the activities included collecting objects through exhibit codes, making notes, contacting people who have collected a particular item, recording audio, and taking pictures.
2. Meso level: the meso level examines the learning experience as a whole, to identify learning breakthroughs and breakdowns; it also examines how well the learning experience integrates with other related learning

experiences. In the case of Myartspace, evaluation at this level involved exploring whether there was a successful connection between learning in the museum and in the classroom as well as identifying critical incidents that reveal new patterns and forms of learning or where learning activity is impeded.

3. Macro level: the macro level examines the longer term impact of the new technology on established educational and learning practice. For Myartspace this related to the organisation of school museum visits. The evaluation at this level looked, for example, at the appropriation of the new technology by teachers, the emergence of new museum practices in supporting school visits, and how they related to the original project visions.

For Myartspace, the development comprised four phases: (1) Requirements analysis, to establish the requirements for the socio-technical system (people and their interactions with technology) and specify how it would work, through consultation with the different stakeholder groups; (2) Design of the user experience and interface; (3) Implementation of the service; and (4) Deployment of the service.

In the requirements phase, evaluation established the criteria against which individual requirements would be tested. In the design and implementation phases, formative evaluation activities fed into the design-implement-redesign cycle to aid and inform design. In the deployment phase, summative evaluation activities assessed the extent to which the technology satisfied the requirements.

In general, it may not be possible to evaluate the three levels – micro, meso and macro – during all the development phases. For example, the meso level requires that the technology is in place and is robust enough to allow assessment of the learning and teaching experience and its educational value; so evaluation activities at the meso level could not be introduced until well into the implementation phase. Similarly, the macro level requires that the technology is in place and used for long enough to establish its effects on school museum visiting practice; so evaluation activities at the macro level could not be introduced until well into the deployment phase. Thus, the introduction of evaluation activities at the three levels of the framework may be gradual, starting with evaluation activities at the micro level at the initial phases of development, later introducing evaluation activities at the meso level, and finally introducing evaluation activities at the macro level in the final phase. Figure 32 illustrates this gradual introduction of evaluation activities (see shaded areas) at the three framework levels over the different project phases.

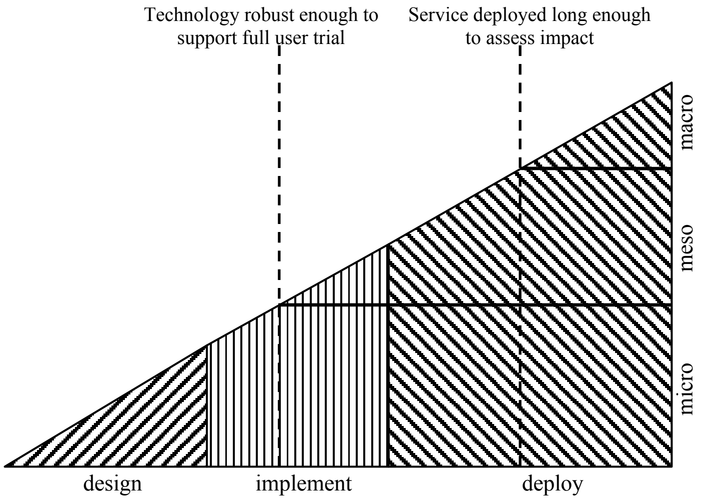

Figure 32: Evaluation activities at the three levels are introduced gradually over the project phases.

To establish the value of the service at the three levels, the evaluation framework explores the gap between expectations and reality and also unforeseen processes and outcomes. This happened in three stages:

1. Stage 1: explores what is supposed to happen at a level. User expectations at each level can be captured through interviews with users (e.g. teachers, students, museum staff) and by analysing user documentation, training sessions and materials.
2. Stage 2: observes what actually happened at a level. The user experience is documented to establish the reality of technology use for the different users.
3. Stage 3: examines the gaps between user expectations and reality through a combination of reflective interviews with users and critical analysis of the findings from stages 1 and 2 by the evaluators.

The framework supported a Lifecycle approach to evaluation (Meek 2006), in which evaluation is the centre of the technology development process, from the early stages of design to the final assessment of the technology in a learning context. Evaluation activities are undertaken at key points in the lifecycle of the system design process, with the outcomes of each evaluation informing the next stage of the system development or feeding into an iteration of an earlier stage. Different aspects of implementation of the innovation can be considered in context, and differing kinds of impact can be captured at appropriate stages.

Evaluation activities	Framework level	Project phase
• Scoping study of previous projects and related recommendations • Consultation workshop on 'User Experience' to establish requirements • Workshop to finalise educational and user requirements	All	Requirements
Heuristic Evaluations (examining how system designs compare to expectations re established design heuristics)	Micro	All
Technical testing prior to trials	Micro	Implement
Full scale user trial	All	Implement/Deploy
Stage 1		
• Examine system documentation (Teacher's Pack and Lesson Plans, online help) for descriptions of functionality • Interview teacher prior to lesson to assess level of knowledge and expectations for functionality • Observe training sessions at museum and school to document how functionality is described to teachers/students.	Micro	Implement/Deploy
• Analyse description of educational experience based on Teacher's Pack and Lesson Plans • Interview teachers and museum educators prior to lessons about what they have planned for the students' learning experience • Observe teachers and museum educators while presenting learning experience to students in the classroom/museum	Meso	Implement/Deploy
• Analyse descriptions in service promotion materials, original proposal, minutes of early project meetings • Interviews with stakeholders to elicit initial expectations for impact of service	Macro	Deploy
Stage 2		
• Observe lesson to establish actual teacher and student experience of functionality • Interview teacher after the lesson to clarify experience of functionality • Questionnaire and focus groups with students to capture experience of functionality	Micro	Implement/Deploy
• Observe educational experience in museum/classroom o Note critical incidents that show new forms of learning or educational interaction o Note breakdowns • Interviews/focus groups with teachers, museum educators, students on educational experience in museum/classroom	Meso	Implement/Deploy
• Review of press coverage and interviews with stakeholders to document impact/transformations effected by the service	Macro	Deploy
Stage 3		
• Capture expectations-reality gaps in terms of user experience of functionality through reflective interpretation of documentation analysis in the light of observations; and also through interviews and focus groups with teachers/students.	Micro	Implement/Deploy
• Capture expectations-reality gaps in terms of educational experience through reflective interpretation of documentation analysis and observations; and also through interviews/focus groups with teachers, students, museum educators.	Meso	Implement/Deploy
• Reflective analysis of expectations-reality gaps in terms of service impact	Macro	Deploy

Table 9: Evaluation activities and methods used at each level, for each project phase

Table 9 summarises evaluation activities and methods in the Myartspace project at each framework level, for all project stages. The three-level evaluation framework provided an efficient way to structure both the data collection and analysis for the evaluation of Myartspace, allowing the documentation of the potential of such a service.

Successes and failures of the service at all levels, micro, meso and macro were identified, along with inter-level influences. For example, in the museum, we noted that collection of museum objects, photographs and audio clips were functions that were easy to use and popular with the students (good usability at the micro level), and students had no problems in assessing/collecting items (good student performance at meso level), a combination that resulted in the collection of dozens of items during the visit. At the same time we found at the micro level that students were not able to annotate their photographs and recorded audio clips with notes describing what they were about or why they recorded these. Although they could create text notes, such notes could not be directly associated with photos or audio clips.

Back in the classroom, the web-based application that allowed students to create their personal galleries was less intuitive to use: users needed more time to technically put an item in their personal gallery that they had needed in the museum to collect that item through their phone. So at the micro level, the web application afforded slower interaction than the phone application for manipulation of the same item. In addition, students needed more time to interpret a collected item in the classroom than they had needed to assess and decide to collect that item in the museum, a difference related to student performance at the meso level. For photographs and audio recordings this was partly because the students had lost contextual information relating to what the item was about or why they had collected it – thus micro-level issues in the museum gave rise to or amplified meso-level issues in the classroom.

The three-level framework provides a structured format to assess usability, educational and organisational impact, and their inter-relationships. In relation to the requirements for mobile learning evaluation presented earlier: it can illuminate learning activities and contexts at different levels of detail; it relates the intended learning processes and outcomes to observed activities and examines the gaps between expectation and reality; it involves learners and teachers as informed participants in the evaluation process; the focus on interaction puts equal emphasis on the learners and the technology; it can analyse individual interactions, educational processes and organisational change; and it can be applied to formal or informal settings.

CONCLUSIONS

The six challenges in mobile learning evaluation identified in this paper are a direct consequence of the complex nature of mobile learning as we have come to understand it, as a social rather than technical phenomenon of people on the move constructing spontaneous learning contexts and advancing through everyday life by negotiating knowledge and meanings through interactions with settings, people and technology. Although in this paper we discussed these challenges in relation to evaluation, other stages in the development of mobile learning (such as design and deployment) are facing similar challenges, which mobile learning research needs to address.

The mobile learning evaluation framework presented here was one attempt to meet these challenges. Its application in the context of Myartspace was successful and offered valuable insights to the project. Although we believe the framework is transferable to other mobile learning contexts, it needs further development to address, for example, contexts with higher ethical concerns. The outcomes of an evaluation based on this framework can feed directly into system design, as has happened in the case of Myartspace. Perhaps with suitable extensions the framework could serve the design process more directly, guiding mobile learning designers to interpret and implement requirements for learning across self-constructed contexts.

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Mobile Learning in Context: School Science Data Collection as Legitimate Peripheral Participation?

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ABSTRACT

We discuss school trials carried out within the Participate project in terms of situated learning theory. School pupils use mobile sensors to collect scientific data in their local areas. These data are then visualized in Google EarthTM or Google MapsTM, and uploaded to a dedicated website along with associated material created by the pupils. These can then be shared with pupils and teachers in other member schools. We consider the importance to children's understanding of contextual information about the circumstances in which data are collected, alongside the idea of 'context' in terms of situated learning and its central concept of legitimate peripheral participation (lpp). We consider the argument that learning can only take place in the context of use of the knowledge in question, and concur with the intention of situated learning theorists that lpp should be thought about in terms of an analytical perspective, as opposed to an educational technique which can or should be implemented in educational settings. However, we argue that providing children with the wherewithal to collect, visualize and discuss their own scientific data is not only an effective and engaging way to learn about science, but also has the potential to enable them to be helped to engage at a basic level with data provided by professional scientists, and thereby with scientific practice.

Author Keywords

Science Education, Mobile Sensing, eScience, Situated Learning, Legitimate Peripheral Participation.

INTRODUCTION

Participate is a large scale collaborative project which aims to use pervasive technologies to inform environmental debate, among groups such as school pupils, computer gamers and community groups. Participants are encouraged to contribute their own material, in the form of text, images and video to supplement professionally produced content. A specific objective in relation to schools is to engage pupils in science learning by providing tools to enable them to conduct and report upon their own scientific investigations. Using mobile sensors and digital cameras, children collect data on environmental parameters, visualize it in Google Earth™ or Google Maps™, and then share it with pupils and teachers in other schools via a secure website. The project builds upon previous work, notably that of Roy Pea and his colleagues (eg Pea, 2002; Edelson et al, 1995; Gordin et al, 1994; Gordin and Pea, 1995), who from the early 1990s, disputed the emphasis prevalent within much of the computer-assisted learning community, on the learner as an individual, and learning a purely cognitive activity. Using the technologies then available, this team aimed to make possible new forms of science education in schools by replacing the traditional teacher-led classroom with a model where learners were immersed in what they termed 'virtual learning environments'; distributed communities of scientists, teachers and students, who collaborated via the internet and other digital technologies. This body of work was a distinguished precursor to what we have termed 'educational eScience'; the use of ICT in education, to enable local and remote collaboration on scientific topics and with scientific data (Woodgate and Stanton Fraser, 2005).

Much of the more recent work in this vein has taken a mobile turn. For example, the Ambient Wood project was based upon a 'playful learning experience' in the form of a digitally augmented field trip in a Sussex woodland (Rogers et al 2004). Pairs of children equipped with mobile devices explored the physical environment, noting the animal and plant species present and taking measurements of abiotic factors such as light and moisture levels with bespoke probes, whilst at the same time receiving multi-modal information via a PDA. Afterwards, they reflected upon and discussed their experiences with an adult facilitator, and were encouraged to hypothesize about what might happen in the wood in the long term under various conditions, such as drought. They also created food webs for the woodland as a follow up activity back in the classroom, using the data they had collected whilst out in the field.

Continuing with the theme of environmental science, the SENSE project (Stanton Fraser et al 2005) aimed to support collaborative scientific investigation not only within individual classrooms and schools, but also across schools, and with professional scientists. Children at two schools collected traffic pollution data in their local area, using sensors which they had helped to design. One child in each group also captured video of the data collection activities. The data, along with the video footage, were then downloaded to a visualization tool which helped them to analyze their data and to understand it in the context of the circumstances of its collection. Children in Nottingham and Sussex then shared and compared their findings using an identical interface. They also discussed their data remotely with a pollution expert. Research findings suggest that this context-inclusive approach is significant for three key reasons. Firstly, it allows individuals to reflect upon method as part of data collection. Secondly, it provides an aide-memoire to groups who have collected data together when they come to interpret their results. Thirdly, it allows new participants who have engaged in similar processes, but separately, to understand new perspectives on their own and others' data. We re-engage with the idea of 'context' further on.

On a much wider scale, the idea that children, along with other members of the public, can collect data to contribute to a national picture of environmental situations, lay behind the Springwatch and Autumnwatch surveys, launched in 1995 by the BBC in association with the Woodland Trust and the UK Phenology Network. These surveys are still ongoing. Participants are asked to record the date of their first sightings of easily recognized indicator species, together with a grid reference or postcode of the location where the sightings take place. Data are input, and collated results viewable, on web pages on the BBC website. Associated with the project, a popular TV series shows the progress of selected species, such as breeding birds, throughout the season. These activities are significant not only because they engage people in collecting data in their own local environments to contribute to a growing and dynamic archive, but also because of the idea of members of the public contributing to, (as opposed to being mere consumers of), professionally produced media content, based upon promoting discussion about environmental topics. This idea of user generated content (UGC) is central to the Participate schools studies.

Our early papers based on the Participate studies have been quite practical in nature and approach, for example on the organizational issues and constraints of carrying out technology research work in schools (Woodgate and Stanton Fraser 2006), reflections upon participatory design exercises carried out 'in the wild' (Woodgate et al 2007a), technical issues (Kanjo et al 2007), and consideration of how best to go about providing elements of an authentic experience of scientific investigation for schoolchildren (Woodgate et al 2008, Woodgate et al 2007b). This line of work was aimed at addressing specific research questions related to technology, student and teacher motivation, and the integration of novel methods with existing structures such as the National Curriculum. It is now timely to move forward to reflect upon some deeper questions, both those explicit in our original research proposal, and others raised during earlier stages of the research, in the light of relevant theoretical perspectives. This is not a trivial matter, since, as Sharples et al (2007) suggest, the effective analysis of mobile learning may require the establishment of new theoretical frameworks, as existing ones take insufficient account of the mobility of learners and learning. In common with most, if not all, new disciplines and sub-disciplines, it is probably true to say that mobile learning *practice* (or at least, the possibilities that it raises to transform learning) currently outstrips the development of *theory* with which to reason about it. This paper is intended to contribute to this debate, by revisiting an existing theory, that of situated learning, and in particular its central concept of legitimate peripheral participation (Lave and Wenger 1991). Linked to this, we wish to pick up upon a key finding of the SENSE study, that of the importance of contextual information on the circumstances of data collection activities, to children's understanding of scientific measurement. The idea of context, in all of its guises, is central to situated learning, and deserves, we think, further careful exploration.

SITUATED LEARNING AND LEGITIMATE PERIPHERAL PARTICIPATION

We draw upon a body of work in the discipline of Science and Technology Studies (eg Collins 1993; Latour and Woolgar 1986), which sees knowledge as socially constructed, and as the collective property of a culture or 'form-of-life' (after Wittgenstein 1953; Winch 1958), and also psychological perspectives on situated learning (Lave 1988; Lave and Wenger 1991). In this tradition, learning resides in processes of co-participation, rather than in the heads of individuals. Situated learning implies more than 'learning in situ', or 'learning by doing', with which it is often roughly equated, and a central concept is that of Legitimate Peripheral Participation (LPP). People begin to learn a skill, trade, or body of knowledge by firstly observing others who are more experienced, and then participating in small aspects of it (ie, 'on the periphery'), and they gradually become able to participate more fully as they become more adept. This model thus rejects the idea of knowledge as a substance which people possess, and learning therefore as the process or processes by which it can (however problematically) be transmitted from one person to another. Rejected also, implicitly or explicitly, is the dichotomy between 'vocational' and 'academic' education forms, where vocational studies are often seen as inferior to purely 'academic' courses of study. It is argued that *all* learning is situated, and even so-called 'general', 'theoretical' or 'abstract' knowledge is only of use in relation to specific circumstances (Lave and Wenger 1991 p. 33-34). Taking our present domain into account, this implies that science is best learned by *doing* science within a community of practising scientists. If we accept this view, there are far reaching repercussions for the teaching and learning of science in schools. This is important, because science is often seen as a 'hard' subject, and rejected by students on that basis, in favour of other disciplines which are considered to be 'easier'. This has led to a situation where relatively low numbers of students are choosing to study science beyond the end of the compulsory period, raising anxieties amongst politicians and the media, on account of the perceived need for a scientifically and technically skilled workforce to secure the future competitiveness of the UK.

It is often conventionally (and uncritically) assumed that school subjects are '*Learned in the normative way in which (they) are taught, and then quite literally carried away from school to be applied at will in any situation which calls for (them)'* (Lave 1988 p.4). Situated learning theorists however are often dismissive of the idea of 'schooling' as something separate from wider experience, as this view implies. Numerous studies (eg Cole et al 1997; Lave 1988) have shown examples where people who can quite successfully undertake complex tasks in context (eg, in the workplace) but are unable to complete apparently identical tasks if they are decontextualized from normal everyday working life and experience, for example as part of a psychology laboratory experiment or in a classroom situation. This suggests that that what is being observed or measured in these two types of situations is in some or other way not equivalent. In this estimation, if there is a sufficient disjunction between the skill being taught and the context in which it is ordinarily practised, a situation could develop where the learner becomes adept at managing the learning situation, but never actually masters the skills in question (Lave and Wenger 1991). This raises the questions of whether classroom based schooling in science could ever be conceived as legitimate peripheral participation in science practice, and if it somehow can, exactly which aspects of an authentic scientific context could be reproduced.

METHODS

At this stage of the research, our research questions centre upon questions of context and appropriate data representations for learning and collaboration. Our methods are evolving as we progress. We have devised online pre- and post-test questionnaires for pupils to gauge subject knowledge and attitudes to collaboration before and after the activities, and to elicit feedback on the activities and technologies. We carry out participant observations inside and outside of the classroom as activities take place. This often involves accompanying groups of pupils outside, as they move through the environment collecting their data and then following them back inside to undertake reflective activities and think about how to communicate their ideas and findings. We seek feedback from pupils and teachers during and directly after the sessions, and interview teachers after periods of activity. Many sessions are video recorded for subsequent analysis. We constantly monitor activity on the Participate Schools website and are in frequent contact with member schools.

THE PARTICIPATE SCHOOLS TRIALS

The Schools Trials cover two main periods of activity, the first of which took place over three weeks in the Summer Term of 2006, and the second still ongoing. School pupils are provided with tools to enable them to collect, analyse, display, discuss and share environmental data relating to their local environments. The Stage 1 Trial was a small pilot study in which we worked with two schools to test out a range of technologies and activities. For Stage 2, which began in Summer 2007 and currently continues, we are working with 15 schools at differing levels of participation and this figure is likely to increase somewhat as we approach summer 2008.

Stage 1 Schools Trial

This study took place just six months into the Participate project. Activities were centred around the idea of journeys; the regular journeys that children make between home and school. Classes of 13-15 year old pupils in two schools were loaned sets of data collection equipment. These comprised a Science Scope Logbook datalogger with a selection of sensors from which the pupils could choose, and a Nokia 66 series mobile phone with sound sensor software developed within the project, connected via Bluetooth to a GPS unit, the idea being that all the latitude, longitude and sound data would be saved in the phone's memory to a time-stamped KML file, to be displayed as trails on high resolution 3D maps in Google EarthTM. Sensor data from the Logbooks were to be displayed separately as conventional line graphs. Disposable cameras and notebooks were also provided. Pupils took turns to take a set of the data collection equipment with them on their journeys home from school, collecting data as they went, on parameters such as carbon monoxide (CO), sound and temperature. The idea was to produce a snapshot of the conditions that they experienced on a daily basis, to promote discussion about how their personal journeys, whether by car, bus, bike or on foot, impacted on the environment and quality of life locally, and how the environmental conditions that they encountered on their journeys may in turn affect them. On their return to the classroom the next morning their data were downloaded to a PC.

Figure 1. A group of pupils working with the phone sensors used in the Stage 1 Trial.

The pupils were briefed beforehand that the trial would include new technologies that had not previously been tested in schools, and that consequently, they might experience technical problems. In the event however, the only notable problem was an intermittent loss of connectivity between the phones and the GPS, due to a software problem. Despite this, pupils succeeded in collecting short sequences of simultaneous sound and GPS data with the phones. These sequences were then manipulated by project team members to visualize them as data trails in Google Earth^{TM}. The trails showed in detail both the routes that had been taken by the students through the local streets and a graphical representation of the data collected along the routes. An example is shown below in Figure 2. Unsurprisingly, the pupils were very engaged by the Google Earth^{TM} visualizations, and the data trails provoked considerable, excited discussion about the routes taken, and possible causes of the data peaks shown. Even at this early stage, the visualizations also provoked discussion which went beyond the particularities of the local events concerned. This included ideas about the ways in which such methods could potentially be used by local authorities to monitor pollution in the locality, the implications of traffic pollution for childhood asthma, and issues such as espionage, surveillance and personal security.

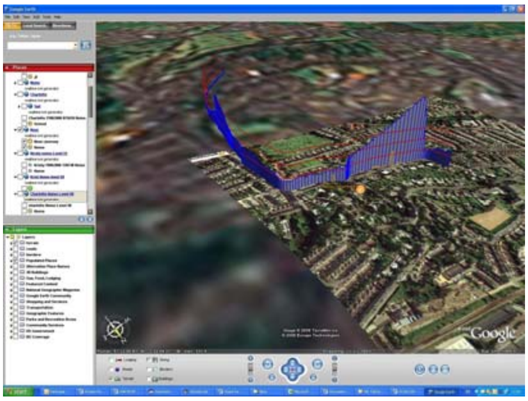


Figure 2. A data trail in Google Earth^{TM} from the pilot trial.

Data from the Logbooks were downloaded to Science Scope's graphing software (Datadisc Pt), displaying as time and date stamped line graphs in various colours. The pupils worked in groups in the classroom with all of the materials that they had collected. Although the pupils' excitement about the Google Earth^{TM} visualizations was perhaps unsurprising due to their novelty and level of detail, we were a little surprised at the extent to which the other quite bland seeming materials that the pupils had collected during the course of this pilot study also appeared to engage them. This comprised printouts of line graphs, some rather poor quality photographic prints and a few handwritten notes. Although these data lacked the immediate impact of the Google Earth^{TM} trails, pupils nevertheless spent long periods of time examining them, attempting to make sense of their results. Video analysis shows that one group of girls spent around 45 minutes discussing this material. First, they established who had collected the individual datasets represented by the graphs, and related them, where possible, to the photographs. They did this by memory; each remembering aloud when she had taken the equipment on her journey, and recognising landmarks or events shown in the photographs. This process involved considerable debate, prompting of one another, and reconstruction of events. Once they had established ownership of the data sets, they then moved on to discuss what might have been happening at various points on the graphs, using the photos, where available, to hypothesize about causation. Finally, they made a poster, linking together the graphs and photographs with short passages of text detailing their reconstructions of events and presenting their findings. Although these data had seemed unexciting, and their interpretation required considerable effort on the part of the pupils, they seemed motivated to do so, because the material was personal to them, and reflected their own activities. A photograph of these girls' poster is shown in Figure 3.

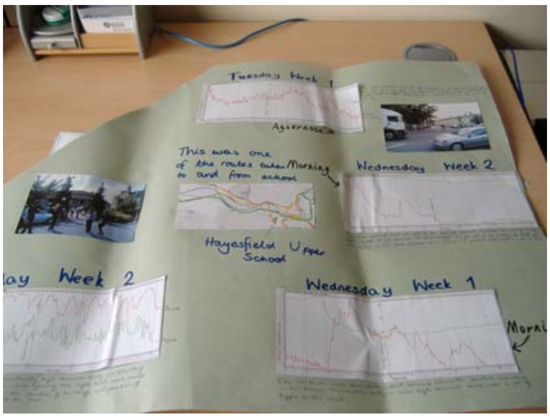
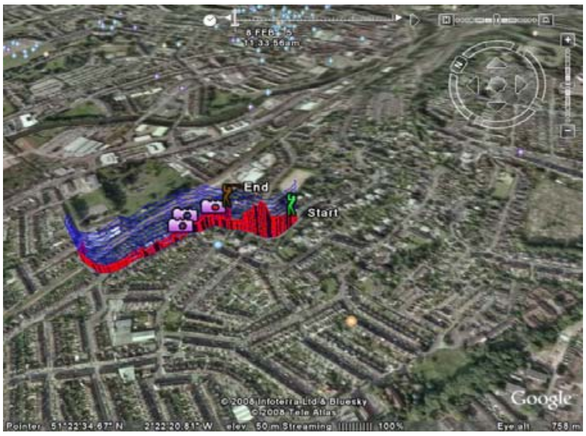


Figure 3. Poster made by pupil group.

On the last day of the trial, BBC colleagues ran a '60 second scientist' film-making workshop at each school. A production team helped groups of pupils to make short films centred around the trial activities and findings. Each group was given a topic or question upon which to base their ideas, and the children were shown how to storyboard, shoot and edit their own short films. The day finished with a general viewing of all the films. This activity was intensive and engaging, encouraging pupils to reflect not only upon both their own activities and findings, but upon environmental issues more generally. They spent a great deal of time discussing their experiences, coming up with ideas, and looking for additional information on their topic on the internet, and among the resources present in their science classrooms. Some moderated sample films are available to view on the public area of Participate Schools website. On the basis of our observations, we decided to include an adapted version of the poster making activity and of '60 second scientist' in the second trial.

Stage 2 Schools Trial

This larger trial builds upon the earlier development work, and is based around a secure website (www.participateschools.co.uk), which enables the upload and sharing of data trails, and of digital posters and short films based upon locally self-collected data and data collection activities. As in the earlier trial, dataloggers, sensors and GPS are used, though some changes have been made to the technology based upon revised research requirements, feedback from participants, and the need to render the activities more appropriate for the involvement of multiple schools. For example, this time we are not using mobile phones, both because of the difficulty of providing the number of phones that would be required for an extended trial across many schools, and also because the team members responsible for working on phone software were at that point concentrating upon other areas of the research. We retained the compelling Google Earth™ visualizations, and Google Maps visualizations are now also available if preferred. This time round, data from the loggers and GPS are downloaded to a program called JData3D, which has been produced within the project. This program automatically displays the time and location stamped data as trails in Google Earth or Google Maps. Additionally, pupils' digital photographs can be incorporated with the data (in Google Earth only, currently), and opened by clicking on placefinders sited at the appropriate points along the data trails. Figure 3 shows an example data trail with placeholders. Alongside the ongoing schools activities, one-off studies have also been conducted at out of school events for children and young people. For example, related activities were presented at the World Scout Jamboree which was held in 2007 in the UK and also at a media event which took place in Bristol.



4. Google Earth data trail showing placefinders for pupils' photographs. When clicked upon, the photos open at the location where they were taken.

Pupils between the ages of 11 and 16+ years, along with their teachers, have used (or are currently using) the schools website. Teachers tell us that the types of activities supported fit well with parts of the Key Stage 3 National Curriculum, and support aspects of GCSE curricula (particularly the new How Science Works curriculum), and also A level work in Environmental Science. They also support aspects of initial training and continuous professional development for teachers, which, since many of these teachers will recently have completed science degrees, hints at least, at the possibility of learners at various levels of scientific expertise interacting and learning together. Pupil and teacher feedback indicates that the activities are engaging and enjoyable. Bristol teacher K.F. remarked of one group of pupils who frequently exhibited disruptive behaviour in class and achieved poorly, that she was amazed at the both extent of their engagement, and the knowledge about technology that they displayed. The Google Earth and Google Maps visualizations in particular, prompted Hampshire teacher H.E. to comment '*It is a real wow factor, the fact that it opens within Google Earth and goes in, and it is their data, and that is really powerful*'. Children also show keen interest in material contributed by other pupils, both their own classmates, and those in schools elsewhere.

Information on the context of the data collection, to assist in its interpretation and the understanding of its significance, is provided by means of Google Earth or Google Maps visualizations, with the addition of time and location stamped photos in Google Earth if wished. These visualizations are very engaging. However, we would like to make a few observations on the question of contextual information, and the idea of 'context' more broadly. Firstly, the most appropriate contextual information depends upon the circumstances of use. For some purposes, Google Maps provides clearer information than Google Earth. We think that this is because the Google Earth visualizations can get rather cluttered if lots of photos are added, and the calibration lines can cause confusion for younger children. However, all participants have enjoyed manipulating the Google Earth screens, and identifying familiar landmarks. This may be partly due to its relative novelty value. Even less obviously exciting material though, if it relates to self-collected data, is also engaging for children, even though context information can be rather lacking, as we noted earlier in the case of the group of girls who took part in the Stage 1 trial, and their poster making activity. However, to some extent this group constructed their own 'context' to make up for what was lacking, in their collaborative reconstruction of the events in which they had participated. This did not of course enable exact pinpointing of locations of the measurements in the same way as the Google visualizations, but they certainly engaged with the data and were able to discuss and hypothesize about its potential significance. In fact, in this very able Year 10 class, we observed that far more discussion *about the actual data* was elicited by simple, time and date stamped line graphs and poor quality photographic prints, than by the Google Earth representations presented in some other classrooms.

On the other hand, the entire process, from data collection, to visualization, to producing posters and films has elicited on many occasions unprompted talk about scientific *method,* even where discussion of the scientific *data* has been lacking. We have also observed informed comment on children's perceptions of the accuracy of the equipment. A number of pupils have commented, for example, about the accuracy (or otherwise) of GPS. Year 7 Hampshire student 'Robert' was only momentarily confused when his data appeared to place him at the top of a building, when he knew that he had been on the school playing field, and he quickly surmised that, as the distance between the building and the position that he had occupied in the field were some eight metres, GPS cannot always be trusted over short distances. In the same class, student 'Tom' was concerned about the lack of time and opportunity to carry out repeat sound level, measurements, because the loaned equipment had soon to be passed on to another school. He commented *'but that's rubbish science because you know, we've only done it once, so how do we really know that that's the quietest place?'* On another occasion, Year 10 Bath student 'Katie' raised her hand and pointed out that the carbon monoxide measurements made mid-morning by her class on the route between the school's upper and lower school sites were *'OK for now, but the levels will be different at the beginning and end of school when there is more traffic. And what about at the weekends and the holidays?'* Some of the films and posters on the website include similar comments about validity of data and the need to repeat experiments to get an accurate picture.

In summary, key findings are as follows:

- As previously stated, *all* self-collected data engaged the pupils. Even quite bland material motivated children and elicited considerable discussion. In fact, some of our studies appear to indicate that more discussion is provoked by less obviously engaging materials than by Google Earth visualizations with associated photographs and textual information. Further work is needed to discover the optimum quantity and type of contextual information to enable understanding, but still require discussion and reflection. This may vary according to circumstances, such as the age and ability of the students in question, and the type of investigation.
- In some instances, Google Maps visualizations can be more effective in enabling understanding of a specific concept than the more immediately compelling Google Earth ones. For example, one group of environmental science students collected water samples at various points along the course of the river, and measured the conductivity levels of the samples (put simply, this is a measure of the salinity of the water, and as a normal course of events, one would expect that the conductivity level would be low inland near the source of the river and rise as one approached the estuary of the river where it meets the sea). This can be a difficult concept to get across when taught conventionally. However, when the sample data were in Google Maps, the variation in conductivity was shown by means of a colour coded key along the course of the river, and the concept is immediately self-explanatory and easily remembered.
- The activities are also useful for teacher training purposes. Teacher H.E. of Hampshire, who was interviewed on 16 July 2007, has responsibility in her school for mentoring newly qualified and student teachers She confirmed that the activities '*will fulfil some standards both for NQT and GTP, PGCE, so it's, you know, working collaboratively and ICT and so on*'.

There is evidence that pupils are thinking beyond the specifics of the results of their investigations, to more general reasoning about scientific concepts. In other words, they are showing ability to move their thinking from the particularities of their own experiences of science, to reason about more general scientific concepts.

DISCUSSION

A set of activities and technologies has been iteratively developed over the course of two sets of trials in schools, to enable teachers and pupils to collect their own scientific data around the school grounds, in the local area, or on field trips. Using a range of mobile sensors, measurements can be taken in the appropriate scientific units, of environmental parameters such as temperature, sound, light and pollutants, and these, along with contextual photographs, can be visualized in Google Earth and / or Google Maps as preferred. Data can be shared in a controlled way with other member schools via the Participate Schools website, and tools are provided for children to make posters and short films about the investigations that they have carried out. When the teacher has reviewed or marked this material, she or he can upload it to the website along with the data files. Collaboration at various levels is therefore possible between children and teachers in schools in different areas of the UK, who can view others' contributions alongside their own and comment or ask questions (and respond to those of others), via a teacher-moderated forum. We have thus made possible the potential for the development of a distributed community of learners in environmental science.

In earlier sections of this paper, we have discussed the importance of contextual information for children's understanding of their self-collected data, and its significance. 'Context' in a related sense, is also central to the concept of legitimate peripheral participation, for there is a strong argument that learning can only take place in the context of use of the knowledge or skill in question. Context in this sense refers to both a physical location, and also the social context of a community of practitioners. Situated learning is ambivalent in relation to schooling. We consider it here in the sense intended by Lave and Wenger (1991 p.41), chiefly in terms of an analytical perspective that is intended to draw attention to facets that are often overlooked in debates about learning, and the effectiveness (or otherwise) of schooling practices, rather than something that should or can be implemented or mobilised for educational purposes. However, even in this sense, it does have implications for how we think about schooling's relationship with wider society, and in particular the communities of practice for which it purports to prepare new entrants. Though the idea of 'operationalizing' legitimate peripheral participation as a 'method' or 'strategy' to be adopted in schools in an attempt to improve learning is anathema to many of its proponents, we offer no apologies for suggesting that providing children with the wherewithal to collect, visualize and discuss their own scientific data is potentially a more effective, and certainly more engaging, way to learn about science than, for example, copying quantities of text from a whiteboard, completing a photocopied worksheet, or doing an exercise from a textbook. We are by no means suggesting that children should never do these things; just that these things should not be *all* that they do. After all, learning about pollution (for example) by observing and measuring it for oneself is qualitatively different from reading, (or being told about) its occurrence, perhaps in an unfamiliar location, such as a city that one has not personally visited. The act of collecting data for oneself moreover gives confidence when approaching data collected by others, even when those 'others' are professional scientists. With guidance from teachers, children can potentially compare their own results for instance, not only with those of other school pupils, but also with those published by their local council, or environmental organizations, because the methods and the equipment used, and the units of measurement, are broadly similar. Co-participation in the skilled community of practice of scientists is thus certainly possible if it is thought about as informed engagement with, and debate about their work.

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TabletPCs in Classrooms: The Impact of Digital Inking and Wireless Technology On Differentiated Teaching and Learning

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Introduction

Studies in recent literature reviews have indicated the positive impact that TabletPCs have in providing a multi-sensory experience in classroom learning (Bienkowski, et al., 2005). Through the integration of educational technology, teachers can actively engage pupils in their learning through enhanced teaching practices. Besides using it as a teacher tool where lessons conducted deem to promote heightened interaction between teacher and pupils, cooperative learning strategies are also infused during task-based activities. Here, the technology offered by TabletPCs facilitates and enhances co-operative learning strategies.

Research Question

My presentation, based on Action Research approach, investigates the following research hypothesis: The use of TPCs and wireless technology in classrooms facilitates a variety of differentiated teaching strategies and learning practices with the harnessing of TabletPC applications. The TabletPC seems to facilitate a more direct interaction between a student and learning material as there is emerging evidence that differentiated learning arises as students use the TabletPC in ways that are suited to their abilities and interests (Bienkowski, et al., 2005). Such applications coupled with teaching resources provide a vast range of activities and approaches that can be crafted for subjects and teaching areas across the curriculum. Pupils with varying learning capabilities and intelligences are also provided more opportunities to be engaged in such a dynamic classroom setting, where the learning environment will promote the active participation of the learners.

Lesson Design

Lessons will be designed by taking into account the different stages of learning, as well as each individual style of learning, and will present communicative activities that are task oriented. The highly interactive learning environment, involves the teacher and pupils speaking freely, asking questions and offering comments and feedbacks wirelessly. Because the unique mobile technology integrated environment optimizes communication and personal interactions, the use of Learning Islands could enhance the instruction and thus allow the teacher to explore the social aspects of mobile learning. Pupils of each of the learning island work cohesively, share their experiences and expertise to construct knowledge collaboratively, thus seeing how texts can be contextualized into real authentic learning.

Data Collection

The rationale of the research is to ascertain if the use of the digital inking feature of the TabletPC and the wireless technology will help promote differentiated teaching and learning as well as increased level of pupil engagement. Convenience samples of pupils are selected to participate in a panel study of a longitudinal survey research. To study the impact over time, information is collected through questionnaires, interviews and observations at different points in time of the research. The research finding will be based on qualitative and quantitative data to show how the advancement of technology aided by such mobile learning devices can positively add value to conventional teaching and learning in the classrooms. Furthermore, drawing upon the pilot, the aim to advocate a vision of mobile learning, where the widespread use of mobile devices such as the TabletPCs, will ultimately impact classroom interaction and pedagogy as well as positively change the way pupils and teachers interact.

Mobile Learning to Bridge the Distance for Adult Learners

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ABSTRACT
Most adults who are working full time have their own mobile devices that they use in the workplace to complete everyday job tasks. Educational organizations need to take advantage of this situation and design courses for delivery on mobile devices so that students who work full time can use their mobile devices to learn from anywhere and anytime. This presentation will describe a project that designed learning materials for delivery on students existing devices and will present preliminary results on this ongoing project.

KEYWORDS
Mobile learning, Workplace learning, Distance Education, Adult Learners

INTRODUCTION
As students completed their course, they were requested to access their regular online course materials from a distance using their existing mobile devices and then asked to provide feedback on their experience using the mobile devices for anytime and anywhere access. The course content for delivery on mobile devices was in XML format using the IMS Learning Design specification. This allows the content to be separated from the presentation and identified specific activities and learning objects within each unit of learning. Also, this allowed content to be displayed in many different formats, in a wide range of layouts, and on a variety of devices.

THEORETICAL BACKGROUND
As many adults go back to school to further or upgrade their education, they will require flexible delivery methods to learn from anywhere and at anytime. The use of mobile technology in distance education allows adult to learn while staying in their own communities with their families and continue to work. There are many advantages of using mobile learning in distance education. A major advantage is that learners can access course materials from any location which promotes learning in the learner's own context..

METHOD
A total of 27 students accessed the course materials using their existing devices and completed a survey to indicate their experience using the mobile devices to access the learning materials from a distance. The average age of students was 29 years. To make this study realistic, mobile devices were not provided to students. They were asked to use their existing devices. Students used a variety of devices to access the course materials from a distance. These include: iPaq devices, PalmOne Treos and Tungstens, Blackberries, Dell Axims, Pantech 3200s, Motorola Razors, Samsungs, UT Starcoms, a Toshiba Pocket PC e330, and even a PSP (Portable Sony Playstation).

CONCLUSIONS
When asked whether using a mobile device to access course materials increases convenience and flexibility in taking courses by distance learning, 91 percent of students either strongly agree or agree. When asked whether it is very useful having access to course materials from a mobile device, 68 percent either strongly agree or agree. The convenience of being able to take the course work along to wherever the students were, and whenever they were able to access their course work was of significant benefit to students. The results from this study indicate that mobile learning provides an enhancement to distance learning through increasing flexibility in course material access. Further research should be conducted to investigate how to use the mobile devices as a support tool in distance education, in addition to being a delivery tool.

Learning on the Go with an iPod Touch: Accessing Multimedia Resources via the Institutional Virtual Learning Environment

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ABSTRACT

Mobile technologies offer a wide range of possibilities for education. Learning on the move is anticipated to be the future way, especially for today's digital native students. By extending the use of blended learning, this project explores the potential of handheld devices as a learning medium. The project is pedagogically driven: the selected course – sport science – has an applied nature with an important practical element. That consists of undertaking a set of experiments in the laboratory. Mobile access to multimedia and other learning resources would allow students to refer to the practical skills at any time and place – even in the field when away from the University. This would be a vital addition to the sport science students' experience ensuring these important practical skills are not neglected.

A series of ten video demonstrations will be available by September 2008. Twenty-five iPod Touch devices were purchased; access and quality of the multimedia resources has been tested on these devices. Mobile access to the Institutional Virtual Learning Environment (VLE) – moodle – has also been tested. Six out of ten video demonstrations have already been filmed, edited and tested on the iPods. Videos will be available in three formats from within the VLE: Flash video (.flv) for access from a desktop or laptop computer, mp4 for access from iPods and 3gp format to be accessed from smartphones. Implementation of the project will take place between October – December 2008, when a group of approximately twenty level two students will be given an iPod Touch for a semester. Feedback will be gathered from students regarding the usefulness of the mobile access to the multimedia resources and the mobile access on the Institutional VLE. A whole unit site on moodle VLE will be converted so that it becomes mobile-friendly.

Students will, then, be tested on the delivery of the experiments covered in the video demonstrations. Their results will be compared with a control group of students that will have access to those resources from desktop and laptop computers only.

The demonstration will consist of two parts: in the first part, a short presentation will be given to introduce the project; following that, 20 iPod Touch devices will be given to participants to test the quality of the multimedia resources and access moodle VLE. This presentation will enable participants to get hands-on experience of both accessing and evaluating multimedia resources and VLE access, using an iPod Touch. At the end of the session, participants will be able to reflect on future directions of mobile learning and the impact of personal handheld devices in tertiary education.

Keywords

Mobile learning, wireless access, sport science learning objects, video on the go

The Techno-Walker

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ABSTRACT

This paper will present the project *DesMarches*, a novel mobile learning experiment in art education organized by the *Centre Turbine*. We invited a group made up of adults, adolescents and children to walk while carrying a camera and wearing a lapel microphone connected to a continuously recording audio device (placed in their backpack), so that they could photograph sounds and add audio to images. For example, they could use their camera to take pictures of sounds such as yapping. They could also create a sound fiction to accompany a photograph. This experience, which draws on an m-learning approach, is characterized by the fact that it does not make use of technologies such as cellular phones or PDAs. We chose simple and affordable technologies to make this project accessible to the school and community milieus, which generally have limited budgets. Like numerous artistic practices that use simple tools and divert them from their customary function, *DesMarches* enabled us to experience and perceive our environment in a different light.

This research is inspired by artistic practices that draw on our environment to gather, fashion and perform artistic creations. In particular, I will focus on practices that integrate walking as an action that fosters an awakening of the senses. During the development of this pedagogical creation project I was inspired by R. Murray Schaffer's work, particularly as it regarded sound-scapes and acoustic ecology which draws attention to the sonic environment.

I will examine three notions: the potential to stimulate context awareness, the multiple sound spaces and the links with the art education curriculum. We walk every day and do not truly pay attention to the intricacies of our sound environment. Contrary to technologies such as the iPod, which isolate the individual, this project stimulates listening in order to make one aware of sound of our environment and its sources. This project fosters the discovery of the material, aesthetic, poetic, social, political and ecological dimensions inherent in the audio-visual dynamic. Secondly, the use of mobile technologies multiplies sound spaces. Through this experience, the participants were put in a state of co-presence within various sound spaces. The continuously recording lapel microphone allowed them to construct and imagine different places and times. The microphone captured the immediate sounds, conversations and the participant's humming. Their vocalized soliloquies added another space; their thoughts were exteriorized, recorded and digitally transposed. To conclude, this project allowed us to attain some of the goals of the visual and media arts curriculum. One of the particularities of our teaching is to have a double mandate: that students develop their cognitive learning and their creativity. This project improves the student's skills in creating soundtracks as part of the video editing process. It is also important to mention that the instruction to photograph sounds induced participants to visually capture sounds rather than creating beautiful images, and further encouraged them to be more spontaneous and free. The choice of framing and composition became secondary. This first techno-walker project allowed each participant to live a singular experience and to gather visual and audio material that will afterwards lead them to get involved in the creation of more experimental video works.

Using Mobile Technology to Enhance the Problem-Solving Abilities of Students in Key Transitional Courses in Engineering, Mathematics and Science

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ABSTRACT

This short paper outlines a pilot study relating to teaching of mathematical problem solving in large first year classes in Engineering, Maths and Science (EMS) using a technologically integrated environment enabled by Tablet PC's and DyKnow software.Two tutorial groups have participated in the study.

The ability to identify, formulate and solve problems is at the heart of EMS education and practice, and is paramount to fostering innovation and creativity. In the large cross-disciplinary context of EMS education, many students struggle to develop and apply the broad range of skills required to solve complex problems, and are at high risk of becoming demoralized and disenfranchised. The high failure rates in some courses attest to the serious impact of this problem. While students are already working in small groups on their problem solving activities during tutorial sessions, they lack rapid feedback from either staff or peers and the opportunity to work through misconceptions at the time of the activity.

In this study, Tablet PC's and DyKnow software are being utilised to provide opportunities for small groups to increase interactivity and receive "real-time" feedback on their problem solving activities from both staff and peers. The use of these technologies also offers greater opportunities for review and reflection. The curriculum has been redesigned to include more interactive, collaborative and reflective approaches to learning in the tutorial sessions. Learning strategies include:

- comparison of problem solving techniques used by different groups
- students using software to indicate level of understanding of concepts: tutor can explain ideas again if majority don't understand, or address individual concerns if only a few students indicate having difficulties
- students asking questions via 'chat' to tutor, to avoid asking 'silly' questions in front of peers
- tutor replaying students problem solving approach, and give feedback on how to improve (rather than just seeing the 'end product')
- students replaying example solutions prepared by tutor, i.e. can watch the process by which an 'expert' solves problems. Some benefit in also comparing an expert solution with a student solution to better understand what the differences are.
-

The paper reports on the development of a comprehensive evaluation process including the development of a "measuring learning matrix" which supports investigation of the following areas:

- Student perceptions of the educational possibilities of Tablet PC's
- Increase in sophistication of students' problem solving methods
- More careful and accurate application of standard solution processes.
- Changes in staff attitudes and educational practice.

Data collection includes pre and post testing of student perceptions, student learning and staff attitudes through observations, surveys, focus groups and test results. A participant perception indicator has been developed to rate staff and students perceptions of their knowledge, experience and confidence in relation to tablet PC's and DyKnow software.

Initial pre test data indicates widely varying differences in the different tutorial groups possibly influenced by differences in staff attitudes. The paper concludes with an outline of what has been accomplished so far, including the challenges in achieving the intended outcomes. **Acknowledgement: This project is supported by funding from Hewlett Packard**

Evolutionary Snapshots of the Mobile Learning Landscape

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ABSTRACT

In any one day, a learner will experience many locations, interactions and situations, with a range of people, places, resources, devices, and objects. This is their mobile learning landscape.

In this paper, we take the above statement as our starting point to frame a discussion of learner journeys through the mobile learning landscape. Drawing on current literature as well as data generated through on-campus evaluations (including semi-structured interviews with staff and students, and results from a Twitter-based exploration of learning space preferences) we will create and present three snapshot visions of these journeys:

- a picture of the current mobile learning landscape – what enables learners to move through this effectively, what hinders them?;
- an 'ideal world' scenario – what would learners ideally like to see?; and
- predictions of how it will evolve in future.

Our discussion will include a focus on the pedagogical implications of mobility as well as the technologies that contribute to its development, and the role of physical and virtual places in our scenarios. We will then examine the steps that we need to take to prepare our students, our staff, and our institutions for the future.

Author Keywords
mobile learning landscape; scenarios; evaluation; learner journey; interactions.

Ubiquitous: a Cell Phone-based m-Learning. Beep Beep… You've got a new SMS

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ABSTRACT

The didactical system of activities proposed by the mobile learning project *Ubiquitous*, is structured and developed on the basis of years of experimentations, which have allowed to collect feedbacks and experiences of the actors involved in the project. The analysis of such data has led us to identify potentials and limits of the learning activities, and has outlined many useful indications for a large scale project development. This information is essential for a project relocation in different training environments.

Author Keywords

trichotomy cell phone-teacher-student, learning activities, k-12 education

BACKGROUND

Supported by Cantonal institutions, Ubiquitous currently is at its third year of testing, involving about one hundred students and nine teachers. The project main objectives are the identification of potentials, limits and flaws of a cell phone-based mobile learning, in order to supply useful information for training and education authorities in perspective of its application in different training and vocational fields.

Ubiquitous's learning activities are designed over solid pedagogical-didactical notions and concepts. The activities are linked to motivational aspects, knowledge organization and knowledge management principles.

METHODS

The main methodologies used through the project are characterized by a thorough interaction with the school environment. The frequent teacher co-operation and the periodical contact with students (blended learning) has allowed the project team to design and test a series of learning activities and to collect direct information on how the project is perceived by the various actors. The gathered data (surveys, post-activity tests, activities' balances, teachers' journals) has supplied relevant indications on how to develop further cell phone based activities.

CONTRIBUTION

The analysed SMS learning activities have highlighted: students' most (and less) appreciated aspects, teachers' and project team's points of view, dynamics hidden behind the engineering process of the implemented activities and the importance of statistical data on participation level and degree of usefulness.

EVALUATION

Empirical-based evaluation of the project's limits and potentials has been carried through, showing teachers and students' opinions (regarding didactical-pedagogical usefulness), as well as the activities' attractiveness and efficiency in educational contexts.

REFLECTION

Three years of project experimentation have allowed to test educational and technological potentials of the cell phone, in relation to training engineering in the field of language learning and vocational education. The application of the developed learning activities has highlighted important aspects, which need to be taken into account when thinking of a larger spectrum application or of a possible relocation into different learning contexts; as well as limitations of a cell phone-based mobile learning.

This experimentation has led to the creation of a competence group of teachers, now able to train and

guide others into cell phone-based mobile learning activities. A catalogue containing all the mobile activities, aimed to test middle school and high school students and to self-train, might be an outcome of the project. Mobile learning can become an important complementary educational tool, helping young men and women coming from various regions and school backgrounds, to reach equal knowledge levels and adequately prepare for final examinations or tests.

The REVEAL Project – A Review of Electronic Voting and an Evaluation of uses within Assessment and Learning

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Background

This short paper presents the findings from the REVEAL project: a two year large-scale, longitudinal, mixed methods research and development study into the effective use of a leading brand of Learner Response System (LRS). The project aimed to disseminate best practice in the use of the Activote learner response and voting system, highlighting key uses and creative ways of working. As the biggest UK study of its type the REVEAL project clearly contributes to the current research field in the area and due to its development focus provides a range of solutions and recommendations for developing classroom practice. It offers a detailed framework for practitioners that highlights ways forward with regards key applications and offers recommendations relating to training and professional development.

Methods

Data was collected through a range of methods: questionnaires, teacher, pupil and LEA interviews and lesson observations. Schools in 11 LEAs across the UK have been visited 3 times which has resulted in 150 lesson observations being completed across all age phases. Each visit also had a development focus with practitioners and schools being supported in their use and progress with the technology by the REVEAL team.

Contribution

The paper explores key findings in areas such as Access, Leadership, Training and Professional Development, Teaching and Learning, Personalising Learning (including Data and Assessment), Questioning, Dialogue and Discussion, Commercial and Technical and Learner Perspective. Key messages are divided into individual, school based and local authority issues.

The paper will then present the developed model for the effective implementation of a learner response system, The Learner Response Technology Pyramid. This model provides the only known framework for practitioners to identify their current level of use and develop their practice. Participants will be able to see and use the technology first-hand.

Evaluation and Reflection

The issues of generalisabiltiy and transferability were considered carefully by the research team, particularly as the developed model was aimed to be applicable across learner response technology generically. The research design ensured triangulation and therefore, as a result, is robust and suggests a level of generalisability and transferability.

The research visits covered a number of local authorities across the UK, both rural and urban. Within these, the schools, colleges and HEIs visited possessed a wide range of characteristics in terms of size, results and student profile. On this basis the research sample is relatively representative, however the issue of early adopting, confident and competent institutions and practitioners must be considered.

The research also identifies a number of areas that have potential to be explored further, these include personalising learning, pupil access and the use of higher specification LRSs.

Mobile Phone Games for Learners in a Rural Area in South Africa

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ABSTRACT

The discourse of educational input to disadvantaged schools in South Africa has historically focused on video as an innovative solution requiring teacher training and support as well as school located equipment. There is a dearth of mathematics and science teachers, and the ones that are teaching are often unqualified. Thus, learning tools that complement teachers in certain situations have a role to play (Coyle et al., 2006), and can contribute when teachers are unavailable. Three different 'content products' were developed using a participatory design approach (Muller, Hallewell Haslwanter & Dayton, 1997). Firstly, 47 short video clips explaining several mathematical concepts were developed. Secondly, a series of 3 entertaining animations exploring key mathematical concepts were developed. Lastly, two mobile phone games were designed and developed. Java MIDP2 and FlashLite standards were used to explore the design and development processes involved with each technology for the purposes of developing models for future large scale developments. This paper describes this work in progress.

Author Keywords

Mobile learning, mobile phones, educational games, mobile games

BACKGROUND

The pre-determined and well-versed sequential step for providing digital developments to under-resourced and disadvantaged schools requires questioning and challenge. The phenomenal rise in pervasiveness of mobile phones in South Africa (estimated at over 43% of which 85% are prepaid users; Global Information Society Watch, 2007) raises the possibility of utilising this pervasiveness to reach learners in a manner that crosses socio-economic boundaries, and in a way that allows the learner to assume greater responsibility for his or her own learning independent of a teacher. Games in educational settings are controversial due to perceived dichotomy between being educational or entertaining. This dichotomy is problematic and often not useful. Games on mobile phones have received less attention but are starting to. For example, The GRID project at the University of Bradford (2005) is developing mobile phone games to improve science and technology performance at school. The potential for games on mobile phones to be educational is an area that requires evaluation and is currently under researched and not to scale.

METHOD AND CONCLUSIONS

The three 'products' in this study have been loaded onto the phones and provided to Grade 10 girl learners in a disadvantaged area in South Africa. A matched group has been selected for comparison. Girls were provided with the phones with no support and training. The implication is that the content must stand alone, be intuitive and effective. A focus of the project is to test the efficacy of digital game-based instruction techniques in traditionally technology underserved areas. A participatory approach was used (Muller, et al., 1997) for development with continuous involvement of the gaming community, educationalists, subject matter experts, teachers, and at later stages, the learners. User testing has taken place and revisions made. Initial evaluations have demonstrated that the phones have been used with no intervention. Final evaluations will take place and will be compared to initial feedback. As this is a work in progress, interesting preliminary findings will be presented to generate discussion. Games and other forms of educational content for mobile phones in South Africa are new and innovative. Indeed, there is a dearth of high quality (pedagogical and production) educational games for the mobile phone in South Africa and, by our reckoning, worldwide. It is the pervasiveness of mobile phones that make them an excellent vehicle to deliver educational content and, indeed a range of other educational services.

Modelling Behaviour in Guided Tours to Support the Design of Digital Mobile City Guides

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ABSTRACT

The use of mobile devices to provide context-dependent information to tourists and other city visitors is now an activity that fits well with the paradigm of informal mobile learning (Abowd et al, 1997; Cheverst et al, 2000; Kray & Baus, 2000; Schwinger et al, 2003). When developing requirements for such systems, some have concentrated on the context and its properties (Paay & Kjeldskov, 2005), while other work has concentrated, in an extension of the implications of the natural, non-computer-mediated behaviour of tourists (Brown & Chalmers, 2003). Both these perspectives are of major importance, as is the nature of the information itself; however, in this paper we concentrate on a new perspective, drawn from the interaction of tourists with a (human) tourist guide. The work forms part of the requirements elicitation phase of a project to investigate the graphic and interaction design issues of developing an audiovisual cultural heritage guide for the casual learner.

In order to achieve a system that would be welcomed by the target user group, we think it's necessary to make a close observation of current tourism practices and behaviours. Many tourists employ the services of a guide, either on a traditional package tour, or, increasingly in the world of short city breaks, in the form of a small, relatively informal walking tour, where the cultural, historical, artistic and social aspects of the cityscape are explicated on the move. We intend to study both types of experience. In order to understand what people expect of cultural and historical tours and identify which aspects are involved during those activities, we observed, as participants, three different walking tours from the programme of the Fringe Brighton Festival in Brighton, on the south east coast of England. The tours were selected on the basis of their cultural and historical characteristics. The first was a "Historical Central Brighton Tour", which provided a general vision of the historical centre of Brighton to visitors. The second was the "St Nicholas Church talk and tour", which presented explanations about a specific landmark. Adding a less architectural and more literary perspective, the third tour was the "Brighton Rock Guided walk" was the last one, which showed the locations of the film "Brighton Rock" and its original inspiration, the novel of the same name by Graham Greene.

The exercise enabled us to find out in what sort of information was traditionally delivered to tourists on guided tours, the questions they asked, the rate and speed of information flow, the characteristics of those on the tour and their behaviour during the tour. Given the limitations of the casual observer method, however, we are currently planning a follow up activity, in which a group of volunteer "tourists" will take part in a professionally-guided tour and subsequently take part in a focus group to discuss their experiences. Nevertheless, this preliminary fieldwork has been extremely valuable as a pragmatic device for familiarising ourselves with the cultural heritage domain and developing a basic framework for visitor and interpreter behaviour.

Booklist: 1 x Mobile Phone,

Embedding Mobile Technology in Learning

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ABSTRACT

An unprecedented rise in educational technologies has created a variety of tools for today's teacher to deliver quality education to the intended audience, including the mobile phone.

Mobile phones have the capability to be more than just a tool for education, they can be a resource, an item on the booklist. However, a change in culture would be required for this to be realised and would need to be driven by teachers themselves. This research utilised the basic need for effective communications as a catalyst for instigating change and aimed to determine if mandating the utilisation of a mobile phone would lead to the personal and professional development of the individual teacher involved and therefore instigate further development in regard to embedding mobile technology in education.

A key to student achievement is communications, not only within the classroom but with the most important support system the students has, the family. Research identifies two way parental communications as critical to youth student success. This study looked at teacher, student and parental viewpoints in relation to school communications between the three parties, the parents the teacher and the student. As parents have been immersed in this youth culture of instantaneous responsiveness, there is a growing expectation from the parent cohort of immediacy in regard to communications. Many parents purchase a mobile phone for their children to affect immediate two way contact. Mobile connectivity therefore became the focus of this new communications strategy determining that teachers participating in this study would be allocated a mobile phone in order to exploit the student's social networking skills demonstrated outside of the class and emphasize multi-level communication among students themselves, between students and teachers, and between teachers and parents.

Participation in this research has activated inquiry from all of the teachers involved. Individual continuation of experimentation was at varying degrees of intensity with a correlation of intensity linked to confidence and skills in utilising the functions of the mobile phones. The observation of the student utilisation of the many functions of the mobile device and the returned interactions afforded to the teacher such as text, picture and video informed the dialogue of perception and process, leading to an inquiry or exploration of the experience, beginning a cycle of pragmatic experimentation and development of new applications of mobile technology in learning and assessment environments.

This growth in mobile learning interventions will drive a culture change resulting in a new paradigm in educational delivery being driven from within the institute and not forced via external influences which often lead to a hostile view of the intervention and subsequent rejection. In much the same way that laptop implementations were linked to education and school reform, providing the teacher with a mobile phone was the catalyst to instigate educational reform in regard to mobile learning. This became an important constituent in enhancing communications and staff development for providing a creative and co-operative learning environment.

This paper presents the findings and the innovations resultant from project participation.

Evaluation of an m-Learning Pilot:- Narratives of Workplace Skill Acquisition Using Mobile Phones

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Background
This paper reports on a pilot that involves apprentices working in bakeries. The research undertaken has been based on socio-cultural perspectives and the research study itself has been developed using activity theory (Engestrom, 2001) as a framework.

Research objective
To find out how realistic and practical the use of mobile phones with access social networking tools are, for the construction of eportfolios to be used to assess workplace based skills and knowledge acquisition.

Method
The ongoing pilot involves the use of mobile phones to collect evidence in the form of photos, videos, audio clips and text snippets. It extends on a series of trials undertaken since 2005 (Chan, 2006). The multimedia evidence is stored on multimedia sharing and social networking sites. All the sites utilised to store the evidence is linked to a Moodle (content management system) page set up for each apprentice. Apprentices are provided with ‘teacher’ access and this allows them to hyperlink to collected evidence that is archived on a range of web based mobile phone capable platforms. These platforms include photo and video sharing and personal / social networking sites. The evidence on Moodle is then easily accessible to each individual apprentice and the tutor either via mobile phone or desktop computer.
Evidence collected is collated to form an ePortfolio that is used as the basis for competency based assessments. This ePortfolio is compiled using a range of web based and personal computer based software. The apprentices have a choice on how the ePortfolio is organised, collated and presented.

Contribution
The pilot pushes the boundaries of mobile learning with the use of mobile phones as the main collection tool for work place based evidence. It includes access to an institutionally based content management system. Mobile capable web based platforms are then used to archive multimedia evidence for later collation into ePortfolios.

Evaluation
The pilot has been evaluated via student feedback using impact evaluation guidelines. Activity theory has been used to ground the evaluative study. In particular, activity theory was used to explore the connections between the uses of technology as a tool for communicating skill acquisition attained in a workplace with the process of identity formation of young people as bakers. Further evaluation has taken place within the institution via its elearning and web support team. These evaluations reveal that apprentices find the use of mobile phones for the gathering of workplace based evidence to be an effective and efficient process.

Reflection
The pilot has produced results that have exceeded some of our expectations. In particular, there has been deep engagement in the ePortfolio evidence collection and collation process by students who are often difficult to motivate with regards to providing evidence of their skill acquisition for the purposes of assessment. Another unforeseen outcome of the trials has been that the work produced by apprentices has also flowed into their non-work activities and improved the information technology skills of several of the students. Apprentices have been allowed to select a range of methods for compiling their ePortfolios. This has led to the construction of a diverse range of digital stories that inform assessors about how young people become bakers. Therefore, the ePortfolios have become narratives of young apprentices’ journey in skill and knowledge acquisition as they work towards becoming bakers and mature into young men with diverse interests and capabilities.

Informal Learning Amongst Geocachers : Mobile and Web 2.0 Technologies in Action

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Background

This research examines how mobile and Web 2.0 technologies have been used to create, store and share knowledge in a distributed online community, and the relationship with informal learning. It looks at the distributed, online community of Geocachers who link the virtual social spaces of the internet with the physical spaces that surround them.

Geocaching is like a treasure hunt where members hide and seek geocaches in the landscape. The cache location co-ordinates are posted on the geocaching website and can be downloaded onto a Global Positioning Systems (GPS) device. Upon finding the cache, geocachers write a find log which is associated with the cache. These find logs build up a temporal narrative of the cache and its location. Geocaching combines physical context (GPS location-awareness), social context (the global online community, regional communities and individual groups) and multi-modal narratives (web-based descriptions, dialogues, images and videos) to develop and sustain a dynamic resource-based virtual community.

Methods

The approach taken was to find an enthusiastic community rather than engineer an experiment. Participants for a web-survey were recruited from the geocaching forums and from the 659 responses; five linked case studies were selected. These were interviewed by telephone, or email. This data was supplemented by information collected from the geocaching website and forums and analysed using qualitative and quantitative techniques.

Contribution

Previous studies used mobile technologies to provide situated access to content and collaborative knowledge building (Facer et al., 2004, Futurelab, 2006, Sprake and Thomas, 2007). However, there is less evidence about how mobile technologies are used by people who have adopted them of their own accord. In particular, do they play a role in triggering or supporting informal learning and are the multimodal, collaborative affordances of Web 2.0 also being used.

Evaluation

The findings reveal that geocachers combine mobile technologies with Web 2.0 technologies in innovative ways, devising location-aware activities that connect physical and social contexts, creating a space for informal learning that is under the control of the learners.

Reflection

Formal educators have explored the potential of mobile technologies, and Web 2.0 technologies (eg. podcasts, student blogs, Facebook courses). This study reveals a growing undercurrent of informal learning uses which, because they are not constrained by the requirements of a learning curriculum, can push the boundaries of technology use in learning and demonstrate ways that mobile learning for all may be achievable.

Mobile Learning For All: High-Tech to Low-Tech

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ABSTRACT

Tribal Learning and Publishing (TLP), working with partners on TATE (Through Assistive Technology to Employment) an ESF Equal project led by HFT (Home Farm Trust), developed a set of work-based health and safety resources to support people with learning difficulties. Throughout the project TLP endeavoured to take a person-centred, constructivist approach. We based our thinking on the social model of cognitive disability: a recognition that learning is socially situated, and can only take place if the appropriate context has been created. This provides a rationale for treating each learner as an individual whose diverse needs can be met in a variety of ways. One way could involve mobile technologies – and this was part of the innovative nature of the project.

The research phase involved reviewing policy documents and synthesising key principles to underpin both the project process and the end-product. We also visited workplaces and reviewed existing health and safety resources, which were often heavily text-based and inaccessible to many target learners whose reading and writing skills were still developing (Entry Level of UK Adult Literacy Curriculum). Working with partners (HFT, Portland College, Right Employment), a user-centred project process was then developed to include learners, support staff and employers in identifying requirements, designing the end-product, making good practice video clips, trialling. This process/learning journey (for us all) was seen as important as the end-product.

As a result, our initial vision of the end-product changed. We interpreted "mobile" in the broadest sense, including paper. We also decided to aim the end-product at support workers and tutors since it could then be used flexibly and customised to support a wide variety of learners. What we produced was a backpack of teaching resources including a CD containing audiovisual resources (video clips, animated scenarios, quizzes) and a tutor guide. We also created m-learning versions of these resources to download to PDAs, and a small authoring tool to create customisable prompt cards – pocket-sized, paper-based visual reminders of good practice.

We had adopted a user-centred design process to try to ensure that the resources developed would be fit for purpose. The resources are now a commercial product, *Safe at Work*, but we continue to gather feedback from end-users on the extent to which they are *in practice* fit for purpose and add value to the learning experience. Initial feedback though has been positive. Evidence also indicates that it is being used by a much wider range of organisations than we first envisaged, including ESOL tutors and the probation service.

For us, part of the innovative nature of the work was understanding the experience of those with learning difficulties using mobile technologies to support their health and safety practice in the workplace. In the process we recognised the challenges for some of this target group and looked for pragmatic solutions, while retaining the benefits of technology as a motivator. We believe we finally developed a more inclusive end-product that doesn't stigmatise people with learning difficulties as a separate group. In our session we will bring some of the resources to show and for participants to try out.

Author Keywords
assistive technology, blended learning, context, evidence, feedback, health and safety, high-tech, inclusive, learning difficulties, low-tech, m-learning, mobile technologies, user-centred, work-based

Learner Generated Content For Heritage Attractions Using iPods

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ABSTRACT

The paper reports on research analysing the learning experiences of students developing podcasts for the iPod for the purposes of heritage interpretation. Previous research has investigated the potential of using podcasting in museums. When used in this context podcasting can present different perspectives on museum artefacts, can target different markets and can enhance both the onsite (i.e. tour) and online (i.e. provide additional content) experience. Previous research has also analysed the positive benefits of using PDAs to assist in the interpretation of heritage attractions including accessibility and interactivity. The research takes the theoretical perspective of learner generated content to analyse student experiences of podcast creation for heritage attractions using iPods. Technological innovations in the form of iPods and podcasting have enabled learners to take a more active approach to the creation of knowledge and promote responsibility for their own learning and the learning of others. This research project is therefore grounded in theory on learner-generated content for mobile devices.

The research focused upon a group of students studying a level three undergraduate module entitled "Heritage Management". Students were placed in small groups and were asked to create a podcast of a heritage attraction of their choice, which could be played on an iPod for the purposes of heritage interpretation. In completing the task, students retrieved written and photographic information on their chosen heritage attraction which could then be developed into a podcast. The podcasts were created by the groups in class time. Throughout the process students were asked to compile an individual reflective blog on their experiences of developing the podcasts. Students presented their podcasts as part of a formative assessment and were invited to comment on the podcast creations of their peers. Focus group interviews were subsequently undertaken with each of the participant groups.

Analysis of the empirical data has revealed student satisfaction with this method of learning. The creation of the learning content encouraged a deeper learning experience. Students commented on their greater understanding of principles relating to heritage interpretation and its application to practice. Students also commented on their enhanced motivation to learn. The research confirms previous findings on the knowledge building benefits of this approach to learning. Factors including a lack of self-confidence when using the technology were common amongst the sample group. This suggests that it should not always be assumed that learners have the autonomy and technological know how to generate content.

The research suggests that learner generated content for mobile devices, such as the iPod, enables an enhanced learning experience to occur. However, it should be acknowledged that factors including the novelty of this activity could have skewed the research data towards positive outcomes. Therefore, further longitudinal research is required. Future research also needs to investigate the collaborative elearning experiences of developing learner-generated content for mobile devices.

Integrating Gender and Ethnicity in Mobile Courses Ante-Design: a TELearning Instrument

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ABSTRACT
This paper proposes an instrument developed by the Institute of Tropical Medicine (ITM) that allows instructional designers and subject matter experts (SME) to implement gender and ethnicity in mobile courses from the start.

Keywords
Mobile learning, technology enhanced learning, instructional design, gender, ethnicity.

PROBLEM

Research has pointed out that context & identity are important motivational factors in mobile learning (1). Gender and ethnicity are part of both the context and identity of the learner, thus essential for mLearning. Although research looks at gender and ethnicity during the evaluation part of m-courses, these evaluations are mainly post-design or post-launch.

BACKGROUND

Visual appearance plays a central role to promote intrinsic motivation in the mobile learner. Mobile screens are smaller and mobiles are used on the go; which results in the need for clear visuals that add to the narrative of mobile courses. Clear pictures that depict specific people rather then groups of people are good practice for mobile screens as they give the learner a better focus on the content of the visual.

Having proactive instructional design is significant for learners who belong to cultures that are situated in an unequal relationship with the dominant groups (2). To be inclusive, a balanced presentation of diverse human groups in different non-stereotypical behaviors is required (3). 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 (4).

DESIGN

The instrument is designed as an easy to use checklist that enables both instructional designers and SME to quickly evaluate the gender and ethnicity representation build in mobile courses.

The checklist has two big categories (gender – ethnicity) and zooms in on relevant actions of the represented personae (e.g. does the person have an active role? Is the person depicted in a stereotypical gender situation?). Each checklist option has additional information to clarify the meaning of the box if needed. By checking the relevant box(es) while building a course, the course designer or SME gets a clear idea of the main focus of the used imagery and the roles those images depict. The results of the checklist are easy to extrapolate into meaningful statistics that can be used to further develop the courses and ensure a gender and cultural balance throughout the visuals.

EVALUATION

Although the instrument is still being adapted, it is clear that selecting ethnicities is a very difficult and sensitive process. This selection process needs to be researched to get objective arguments for choosing certain ethnicities.

CONCLUSION

In order to be able to build courses that motivate global learners, it is essential to develop a tool that gives instructional designers and SME a way to introduce gender and ethnicity during the development of mobile courses. This will enhance the learning outcomes of mobile courses because it motivates and tailors to the context and identity of different learners.

Students Using Mobile Phones to Transform their City Gardens into Dynamic Learning Games.

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ABSTRACT

As part of their commitment to learning beyond the classroom, the Government of South Australia's Department of Education and Children's Services (DECS) employs a team of Outreach Education Officers who are based in major public organisations such as the Botanic Gardens, Zoo, Museum and Art Gallery. The role of Outreach Education is to ensure that all South Australian school students and their teachers have the best possible access to the resources and events at those organisations. These teachers have an opportunity to create new educational resources and experiences for visiting students.

In searching for new tools to improve the delivery of the Outreach programs, the Education Officer from the Adelaide Botanic Gardens discovered the Mobile Learning Kit (MiLK). Milk is an authoring tool for mobile learning events developed by staff at the Queensland University of Technology. MiLK allows students and teachers to design and publish their own events that lead people through places with the use of a mobile phone. Significantly, MiLK is designed for students to construct their own learning events, in doing so becoming active participants in their own learning processes. MiLk events are highly valued by students as the web and mobile interactions occur beyond the classroom, including everyday environments and social media. At its simplest, a MiLK event is a sequence of SMS instructions and clues that are written using a simple interactive storyboard. Other MiLK features are group journals, discussion forums, student profiles and tracking interfaces.

Using MiLK was seen as an opportunity to replace traditional paper trails with ones that provide real time feedback to students. Furthermore, MiLK frames students as authors. Taking control of their own learning the students set up structures for others to enquire and investigate. The Education Officer noted that there were "feedback loops of discussion going on as they trialled each other's events…they were stimulated to discuss things because of a natural desire to find out how their game worked". One of the teachers was struck by the amount of higher order thinking that occurred throughout the workshop. He noted how MiLK encourages students "to go beyond answering the questions to actually posing the questions…If you want to look at Blooms taxonomy, they are going right up from a lower level up high really quickly". The students really enjoyed the physical aspect of the workshop with one commenting, "this is so much fun, so much better than sitting in a classroom." They also appreciated the fact that new technologies were being valued in their learning lives and allowing them to learn outside the classroom; "We're learning in a way that is more suited to our generation…this way we can have fun by going around and looking at the stuff in the real world."

Our presentation will be a visual demonstration of how the MiLK was used to engage, excite and improve learning outcomes for a group of secondary students in their investigation of plant habitats and environments at the Adelaide Botanic Gardens.

m-Learning Initiatives in the British Army – The Story So Far

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ABSTRACT

Major Roy Evans is a Technology Based Training expert in the Army who has an MSc in Computer Based Learning and Training. His passion is deriving technological solutions to training problems. One of his key areas of focus is m-Learning and he will be presenting two of his current initiatives, those utilising iPod Nano and Nintendo DS gaming technologies.

The author will explore some of the unique difficulties that a military organisation has to overcome with m-Learning such as culture and security.

Conversely the presentation will further demonstrate the benefits of delivering training via mobile devices, which not only allows soldiers to take advantage of pockets of time whilst on the move but can potentially facilitate elective learning.

Other advantages which present themselves are the training and infrastructure opportunities which can be potentially negated when using COTS hardware which exists in most soldiers' pockets.

The entire process undertaken in the development of the m-Learning initiatives will be showcased including the terms of reference used to run the trials and the approach to using Kirkpatrick's Level 1 & 2 evaluation.

The repurposing of existing materials has been done extensively and much of the software used in the initiatives has been downloaded from the Internet. There has also been commercial support to solve the end to end delivery of materials to users wherever they may be.

Evaluation of the low-level language training is ongoing but all existing results will be shared at the conference including increasing expectation of users, the author will also be showcasing the devices and the materials.

Major Evans will conclude with a summary of the projects and a description of the proposed way ahead for m-Learning in the Army.

Evaluation of Mobile Web Design Guidelines in m-Learning by Using Eye Tracking

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ABSTRACT
This paper shows the results of the evaluation of two sets of mobile web design guidelines concerning mobile learning. The first set of guidelines is concerned with the usage of text on mobile device screens. The second set is concerned with the usage of images on mobile devices. The evaluation is performed by eye tracking (objective) as well as questionnaires and interviews (subjective) respectively.

Author Keywords
Eye tracking, mobile web design guidelines

TEST SETS AND INTENTION

Our last year's study about navigation behaviour on mobile devices the subject was asked the questions one after another. Afterwards he/she had to answer these questions on the basis of content presented to him/her by mobile web pages (on a mobile device). The eye tracking showed that most of the subjects scanned the text for keywords only. Therefore it was difficult for them to memorize anything else than the keywords in the questions and the answers (verified by the interview). The tests also showed that links in the text are very important (verified by eye tracking). Additionally the questionnaire has revealed that many of the subjects (54%) asked for a more multimedia (mainly images) enriched content. As a consequence of the above mentioned issues, the new tests will consider the following aspects:

Eliminate the pressure to **scan** the text for keywords only by offering the chance to read the content. The questions are asked afterwards. Additionally the content was related to the subjects' interest. Finally, images were added to the text as a first step towards a **multimedia enriched** content (Inhoff et al., 1998).

Nevertheless these tests have as a goal the improvement of mLearning web pages. Therefore the tests consist of four different scenarios. In order to be able to compare the results, the content in all four scenarios is the same. The scenarios differ only in the presentation of the content.

Scenario 1: The content is presented on one big page.
Scenario 2: The content is divided into smaller units.
Scenario 3: The content is divided into smaller units, enriched with additional images.
Scenario 4: The content is mostly presented by images, text is reduced noticeably.

In this test set, scenario 1 and 4 are violating the design guideline sets whereas scenario 2 and 3 are fulfilling these sets (Passani, 2008; Rabin et al., 2006). Our main interest is to examine which of the scenarios will enhance the learning process and the understanding. Where “learning improvement” is used in this study, in fact three factors has been observed and measured. The first fact is the number of questions that the subjects could answer correctly after studying the content. The second is the total fixation time (information absorption time) of subjects as a result of the eye tracking test and the third if the subject believe that he/she has learnt something through his/her study (Mayer, 2001). The present analysis will therefore provide hints for the verification or falsification of mobile design guidelines. The following questions will be answered by the test results:

How much attention is attracted by the images on mobile web pages?
What is the percentage of the whole studying time that was spent on images in the mobile web pages?
Does the location of an image influence the attractiveness?
Do images improve the learning in these scenarios on mobile devices?

Engaging Health and Social Care students in Mobile Assessment and Learning

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Background

This short paper will share the experience of the ALPS (Assessment and Learning in Practice Settings) CETL (Centre for Excellence in Teaching and Learning) in delivering mobile assessment and learning. ALPS involves sixteen different Health and Social Care (H&SC) professions across five Higher Education Institutions. The main aim of ALPS is to ensure that graduates from courses in H&SC are fully equipped to perform confidently and competently at the start of their professional careers.

ALPS is working to achieve this aim by focusing on assessment in practice and is delivering work based assessment and hence learning through mobile devices. Currently around nine hundred students are using mobile devices for learning and assessment in work based practice.

Methods

To provide a framework for inter-professional assessment, ALPS has taken an innovative approach and developed three Common Competency Maps for the core skills of Communications, Team working and Ethical Practice. This outcome has been used to develop common assessment tools which are used from a mobile device in ‘practice’. The results of taking the assessments and recording the outcomes are delivered to a portfolio in a secure manner so that student and patient confidentiality are preserved.

In addition to the formal assessment methods, students are using the devices to engage in informal reflection and are able to record their experience of work based practice as a reflective dialogue and by recording evidence against the competency framework. The mobile device allows the use of video, pictures and audio as well as traditional textual methods.

The ALPS use of mobile technology is based on situated learning theories [Lave et al, 1991] that promote and support learning taking place in authentic settings. In the case of ALPS this learning takes place within the context and culture of health and social care practice settings, where students deal with real cases. ALPS uses technology to support conversational learning [Pask, 1976] and reflection-on-action [Schön, 1983]. The mobile devices enable the capture of reflection and feedback from a range of participants (student, peer, assessor, service user or carer and tutor) within the community of practice in which the students are working and learning. The online eportfolio, to which this feedback is sent, also has the potential to act as a shared conversational learning space [Naismith et al, 2004] supporting the student in the continuous building of knowledge and understanding through reflection and dialogue.

Contribution

The five ALPS HEI partners have rolled out mobile devices to 900 undergraduate students in various Health and Social care professions. A mobile assessment tool has been developed which is being used with the competency framework for the assessment of core skills.

Evaluation

The paper will describe this innovative use of mobile assessment and learning and will cover the areas where we now have significant experience relating to a large student group across collaborating institutions. We will cover areas such as the procurement of a large scale solution, engaging the staff and students in a significant mobile learning project, working with e-learning and network suppliers, choosing devices and overcoming cultural and ethical barriers. We will also report on the benefits of the social use of the mobile tools and the acceptability and accessibility of the mobile devices for staff and students.

Reflection

The implementation of this diverse and complex project has produced specific successes with the development of interprofessional skills frameworks, the social aspects of the tool and the use of mobile devices as an aid to learning in work based practice. It has also raised some challenges around how such a project can be embedded in to the mainstream e-learning programme of a University for both H&SC and other subject centres The paper covers these and describes the areas where we are working to influence and change so that mobile learning can embedded in a University provision over the next 2 years.

ERA: On-the-fly Networking for Collaborative Geology Fieldwork

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BACKGROUND

Field-based activities are regarded as essential to the development of a range of professional and personal skills for undergraduate students within geography, earth and environmental sciences. Students are taught investigative skills to enable them to interpret features within the landscape, establish technical skills such as sketching and the use of field equipment, and learn to collaborate with peers. Students enjoy field activities, and these improve deeper learning and understanding. However, due to issues such as cost and access some have little opportunity to participate in field-based studies. The ERA (Enabling Remote Activity) project is investigating how mobile and communication technologies might enhance field learning experiences for all participants. We identify two ways in which supporting technologies can enable greater participation and add value to existing fieldwork: remote access and collaborative group work.

METHODS

In 2006 we enabled a single mobility impaired student to direct a remote geologist in the field, supporting remote access. A rapidly deployable, lightweight, battery powered wireless network was built (which we refer to as an ‘on-the fly network’) to enable the transmission of video, audio, and high resolution still images from the field to the student. In 2007 we supported three groups of volunteers undertaking remote collaboration, with half the participants in a university laboratory and the others in the field location. Each group was carrying out a separate specific geological investigation; graphic logging, paleontology, or mineralogy and paleocurrents. A network infrastructure supported communication and data transmission between the groups. Field and laboratory participants had their own distinct, significant roles and the trials explored how technology enhanced collaboration may be used to improve student learning.

CONTRIBUTION

ERA has tested highly mobile, easily configurable low cost network tools to explore how on-the-fly networking can support geology field studies at undergraduate level in remote locations. We have explored two differing configurations, developed through a collaborative design process undertaken between technology developers and course managers.

EVALUATION AND REFLECTION

A range of evaluation tools were used to enable analysis of the trials. Field journals were kept by all participants, which found ready acceptance with the geologists as an extension of their standard practice of keeping field notes. A wiki was used by the technical team to capture lessons learnt during the development and trial periods. Participants were gathered together for post-trial debrief sessions. In the second trial, participants’ responses were collected through written questionnaires and focus group discussions (audio recorded). Participants’ activities were also captured on video camera and this was analysed to capture critical incidents. Key findings underline the importance of co-designing technology and pedagogy, orchestration of multiple groups, on-site testing, and planning for graceful degradation of technologies and learning activities.

In 2008 we will be looking to move the system from a development prototype to a production model that could be could be replicated by geology departments across the UK without intensive technical support, and the proving of specific technical enhancements including VOIP (Voice Over Internet Protocol) communication and the use of wireless digital cameras.

Engaging the Learner through Game-based Mobile Learning Environments

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ABSTRACT

This paper explores how learners may engage with different mobile platforms in a game-based learning environment. It looks at how three different platforms, may offer affordances for engagement for learners in relation to their modal preferences.

Mobile learning environments can provide the learner with an opportunity to engage in contextual learning. This may create renewed interest in and understanding of a subject that for some learners may otherwise be difficult to engage with, like mathematics. Games and narrative may provide an experiential framework for solving tasks that are contextually anchored in the physical environment and add an affective dimension to the learning situation. This project has developed a game for learning mathematics in secondary school, and subsequently implemented it on 3 different mobile platforms, which have been tested with learners in different educational settings. The platforms range from mobile phone to PDA/Smartphone, to a sensor-based platform.

The methods have been based on action research, testing the platforms through interventions in the schools. Qualitative data have been collected through questionnaires, video-observations and interviews with students and teachers involving 3 schools in 3 different countries.

This paper presents some case-studies based on the trials in the schools and a comparative analysis of the learners' interaction with the different platforms.

The paper presents the preliminary results of the study and discusses its implications for including this type of game-based mobile learning environment in the curriculum in schools. It also discusses its possible implications for inclusiveness by offering an approach that allows for multimodal engagement of the learner.

Author Keywords

Serious games, mobile learning platforms, modal preferences

ACKNOWLEDGMENTS

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Widening Access to Professional Language Through Enhanced Podcasting. From Cabbage to C.A.B.G?

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‘I was sitting in handover thinking what are they going on about and then they started to talk about cabbages and I had to ask one of the nurses what this meant’ (student nurse 2007)

Background

Nursing students find the use of professional terminology challenging. Moreover, their perception of bioscience is as a difficult subject leading to anxiety. There is a requirement therefore to find effective methods of teaching and learning a difficult subject to a student body with a very wide range of academic ability and information, communication and technology skills. Health care practitioners are using mobile learning applications such as podcasting in order to enhance student learning however there is a lack of empirical research on instructional design of podcasting and the involvement of students and tutors as end users in the design process. This paper aims to inform the pedagogical development of enhanced podcasting in nurse education, building on conversational frameworks of learning and teaching cited in the literature and students’ and staff collaboration.

Methods

A participatory action research design was used for the purpose of engaging students and teachers in the development and testing of the enhanced podcasts of clinical terminology. Focus groups interviews were used to capture students and tutors views and perceptions of the possibilities of enhanced podcasts in the learning and teaching experience. Scripting the audio content beforehand proved to be a useful strategy and checking the final product with practitioners enabled the material to be further improved.

Contribution

In the focus groups the students identified that they felt inadequate when listening to handover given by health care professionals as they had referred to patients with a coronary artery bypass grafts (C.A.B.G) as a ‘ cabbage’. Enhanced podcasts were thus produced using GarageBand, the only software available at the time of production, on commonly used terms and abbreviations found in clinical practice. This was also linked to the students’ bioscience lectures. Problems were encountered loading the podcasts onto the virtual learning environment due to incompatibility issues of the files. This was resolved by hosting the podcasts on a mac.com account.

Evaluation

Students, tutors and mentors in practice were invited to provide feedback on the podcasts using an open question via e-mail – 60 responses were received. Post-podcast production focus groups were also held and the data combined. The themes identified included the nature and content of the podcasts, production issues and technical queries. Students with known dyslexia and English as a second language showed that the podcasts enabled them engage with and understand the clinical language because they could repeatedly access the podcast in their own time and at their own pace.

Reflection

Limitations – this is a snapshot of the students’ tutors’ perceptions and views of using new technologies however the collaborative approach enabled innovative ideas to crystallise out of thin air. It is debatable as to whether this level of interaction between students, tutors and mentors can be sustained unless protected time is made available for learning innovations.

Enhanced podcasts may widen the accessibility of the use of professional language in nursing. This in turn may improve confidence and communication skills when the students are in practice.

Whilst the time taken to produce an enhanced podcast is considerable, this is offset by the reusability, cross-disciplinary usage and the relative ease of improving/enhancing the original material.

Identifying the Student Attributes that Impact on Mobile Learning

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Background

This paper addresses the theme of mobile learning for all by exploring the social practice of using a mobile device in the context of different pre-registration health and social care professional programmes. The research participants are studying at one of the partnership sites of the Assessment and Learning in Practice Settings (ALPS) Centre for Excellence in Teaching and Learning (CETL). ALPS CETL has distributed 900 mobile devices with unlimited internet access to students undertaking practice based learning and assessment across the ALPS partnership. It is working towards inter-professional assessment of health and social care students for common competences such as communication, team working and ethical practice using a mobile platform.

ALPS CETL primary concerns are to develop assessment tools which are acceptable to all professional groups and are supported by efficient mobile technology. This paper considers the mobile device as an artifact to support learning in particular contexts and asks why some students are more receptive to it than others. Another CETL Centre for Excellence in Professional Placement Learning (CEPPL) is also exploring the potential of mobile technology to enhance learning in Health and Social Care settings. Despite this potential value, our experience in ALPS to date indicates that although the majority of students are using the mobile devices regularly for multiple purposes, approximately one third are reluctant to engage with the mobile device at all. There is therefore a need to investigate the student factors associated with this disengagement. This will enable us to identify issues that must be addressed for successful embedding of mobile learning and assessment processes.

Methods

A web-based questionnaire, on Bristol Online Survey, will be distributed in June to 130 students studying on undergraduate programmes in Midwifery, Child Branch Nursing, Physiotherapy and Social Work. Survey data will be analyzed using SPSS, to determine the correlation between demographic details, general exposure to e-learning and quality of engagement with the mobile device; in order to address the questions: *"What aspects of the student profile and learning practices promote or discourage sustained use of a mobile device as a learning tool in both work based and university settings?"*

Contribution

These students have been allocated ALPS mobile devices complete with unrestricted internet access for two years. Lecturers working with the groups have provided anecdotal evidence that students are falling into two categories; those who engage with the device and find multiple uses for it and those who ignore it. We have designed a questionnaire to investigate whether any aspects of the students' profile, prior experience or level of current engagement with e-learning on their course, are associated with engagement/non-engagement with the mobile device. We will be able to report on our findings at the conference.

Reflection

This study will contribute to the debate on mobile technology from a social practice perspective by investigating the impact of student attributes on the uptake of the device. Analysis may identify specific challenges involved in widening participation in mobile learning to all health professional students. This survey could be expanded to the other ALPS partners to increase reliability.

The Intersection of e-Science and m-Learning

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ABSTRACT

This paper presents a theory for advancing m-learning research by way of e-science and library and information science methods. E-science can contribute to cost efficient study and creative research techniques for m-learning. Fundamentally e-science is the practice of ensuring data accessibility through its life cycle and of its increasing usefulness for scholarship, research, and study. Preservation is an important component to librarianship in general and can serve to help educators and researchers understand and realize opportunities for digital data in curating digital resources for the long term availability and viability of data on mobile learning research. The challenges to realizing this cyberinfrastructure rest in developing software and hardware workflows to ensure long term access to data.

Author Keywords

library and information science, e-science, m-learning

Methods: Initial Data Curation

At the onset of mobile learning research (such as the collection of GPS coordinates for caching), a librarian or digital curation professional can consult to prepare workflows for storing, preserving, and eventual reuse of the data. Ensuring that geospatial data are secured, identifiable, and accessible in the future will help to reduce costs in education research and development by allowing researchers to build upon the work of those who have already collected data. Re-using and enriching data may help to realize a new form of scholarly communication.

Data Reuse

Digital curation enables new research such as pulling m-learning usability data from institutional repositories that span disparate higher education institutions for a synthesis of longitudinal research without ever having to spend the money to actually perform years of research. This cost effective way of doing research is the promise of e-science. Using the guiding principles of cyberinfrastructure then, data kept in a standardized format and are accessible for m-learning researchers will create a novel kind of research where data gains value as it is re-used. Of critical importance to researchers is having the ability to find, interpret, and manipulate this data for their studies. A usability research project on mobile devices taking place at the University of Illinois at Urbana – Champaign will ultimately store usability data in the institutional repository (http://www.ideals.uiuc.edu/) in the hopes that once the necessary middleware has been operationalized, mobile learning researchers world-wide can make use of this data set (and incorporate other disparate sets) by enriching it for their own use in their research on mobile learning and storing this new data for future use.

Reflection on Preservation

Digital curation is a means to protect data used in m-learning. For clarity a distinction should be made between data used for mobile learning (data used by students) and research data (produced by educators or scientists) about m-learning. And yet, in either scenario the principles of data frailty will emerge as an overarching problem. It may be the case that data collected for a desktop computing project will be re-used for a mobile learning research project--such as studies that have created datasets for desktop systems using mapping data that are then useful for users of mobile devices seeking to enrich location based services. Identifying and curating general computing data for m-learning remains a theoretical initiative at present.

Acknowledgements

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Text Messaging as a Means of Improving Quality of Learning Experience

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Background

The purpose of this research is to investigate if text messaging can be used as a means of improving communications between instructors and students in third-level education. Research has shown that the communication between instructors and students is one of the key factors in the quality of the learning experience of students.

Bloom's Taxonomy categorises the hierarchy of learning behaviours into three interrelated and overlapping learning domains; the cognitive (knowledge), affective (attitude) and psychomotor (skills). The results of research in instructional communication suggest that instructor communication behaviour may have its strongest impact on student affective learning, although certainly impacting the other categories as well.

Methods

In order to explore whether out-of-class (OOC) communication between instructors and students using text messaging can significantly improve students' perceptions of their learning experience an empirical study was designed.

In total 63 undergraduate students from 5 different classes took part in the study, 3 classes of full-time students and 2 classes of part-time students. The students were offered a text messaging service by their instructor and each student who agreed to use the service was requested to fill out a consent form basically allowing the instructor to send text messages to them and receive messages from them with their consent. Over 95% of students who were offered the text messaging service agreed to participate.

The participants received a number of different message types, some for administration purposes (e.g., change of room), some based on the course content (e.g., multiple-choice question), some designed to encourage students to attend class and some that were miscellaneous.

Evaluation and Reflection

The fact that none of the students dropped out of the study suggests that the messages were generally welcome and appreciated, as reflected in their personal comments. A questionnaire was given to participants at the end of the study and in a free-form comment section at the end of the questionnaire several students explicitly stated their appreciation of the service ("good service to students", "very good idea") and recommended further extension ("should be used with all lectures", "should be applied to all").

The participants perceived the instructor as closer and were therefore more likely to ask questions in class and engage in discussions with the instructor. Other studies have shown that this improved communication enhances affective learning, leading to improved attendance, retention, and student engagement as well as other desirable traits. Of course such a service to students requires some additional effort on the part of instructors, however the effort is minimal and the benefits which accrue make it very worthwhile.

$1 Internet - Exploiting Limited Bandwidth in Developing Countries

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ABSTRACT

INFONET-BioVision.org is a freely available internet based knowledge-management system, funded by the Liechtenstein Development Service (LDS) and the BioVision Foundation for Environment and Development that offers Kenyan farmers information on affordable, effective and ecologically sound technologies in crop and livestock production as well as environmental and human health. One of the challenges faced by the project is the secure provision of information to the rural areas that would most benefit from advice on crop pests and productivity [Avallain, 2008]. Bandwidth is sometimes available in these areas, but is limited, unmanaged and relatively expensive. This paper discusses current work in the development of a novel system that brings together hardware and software to make better use of available bandwidth, whilst offering a financially viable and sustainable method of extending internet provision to these hard-to-reach areas, providing rural farmers with access to the INFONET-BioVision platform and other internet based sources of information.

The system currently in development is premised on the fact that some internet based applications require more bandwidth than others. Moreover, their real-time requirements differ greatly. Although it is conceivable that a number of users can share low-bandwidth connections, the multiple bandwidth requests created can easily overwhelm the connection due to the way in which these are managed by protocols developed for bandwidth-rich countries. This results in virtually no bandwidth availability for the user applications themselves.

It is clear, therefore, that to maximise the number of users on one low-bandwidth connection, allocation should take place before applications actually make the bandwidth requests. Indeed, similar bandwidth management exists on a larger scale, with domestic broadband providers controlling the amount of data provided through existing channels to a home user at the exchange, based on a tariff system.

The system effectively applies a scaled down version of this scenario to available connectivity, be that GPRS, satellite or wired. An inexpensive single-board computer acts as a hub between users and internet, allowing software management of bandwidth and connectivity to users mobile devices through Wi-Fi, Bluetooth and wired LAN. The allocation of bandwidth to each user is based on a voucher system that effectively splits the cost of the connection. Users purchase these vouchers, which are priced according to usage, ranging from very low, none real-time e-mail access to more expensive web-browsing, prior to accessing the system. The proposed system is intended to provide communities with inexpensive connectivity through shared costs which is scaleable, such that, should there be a requirement for extra provision of bandwidth or number of users, subsequent devices can be added or moved simply, easily and at low cost.

The system is scheduled for testing later in 2008, at which point a full evaluation will be undertaken.

Avallain, “Organic Farming–a vision for Africa?”, http://avallain.blogspot.com/search/label/Africa, 2008

Authentic Affordances of Smartphones for Teachers and Trainers

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Background

This paper describes part of a wider project in Australia that involved teachers and students in the Faculty of Education at the University of Wollongong using mobile devices as tools in the learning of a variety of subjects. The aims of the research, reported here, were to evaluate pedagogical strategies for the use of a smartphone as a cognitive tool, and to observe and document students' use of the devices as they completed an authentic task relevant to their professional context.

Methods

The research was carried out with a class of 14 students studying for a post-graduate degree in adult education. These students come from a variety of backgrounds with the intention of entering or furthering their careers as teachers and trainers in the university, vocational education, or adult and community education sectors. Short videos explaining or demonstrating concepts/skills are becoming commonplace in these contexts and students were required to create a 2-3 minute teaching episode (digital narrative) following the procedure below:

- Choose an adult education skill they wished to teach
- Write a storyboard demonstrating the skill
- Capture and create pictures and videos using the smartphone
- Download multimedia into movie editing software (e.g., iMovie
- Record audio narration, and insert music and sound effects (e.g., using GarageBand).
- Upload and share video using social networking software (e.g., TeacherTube):
- Provide peer feedback on storyboards and teaching episodes through the LMS subject forum

Students were then interviewed individually on:

- their views on the technology affordances of the smartphone for teaching and learning in adult education
- pedagogical strategies that they believe facilitated the use of the smartphone in authentic learning environments in adult education
- pedagogical principles that they believe facilitate the use of the smartphone in authentic learning environments in adult education.

Results

Interviews and observations indicated that students found the task challenging and worthwhile. The students saw the affordances of multimedia available on the smartphone as powerful enablers for the task. Most agreed that they would continue to develop similar tasks for professional purposes for students in their own classes. One major limitation involved incompatibility issues involving video files. Interactions on the course LMS forums demonstrated students' willingness to engage with the problem and their peers to solve these issues. One of the student's products will be demonstrated and audience feedback elicited.

Reflection

It is useful to conduct an initial group activity where students create a fictional digital narrative or story, by first constructing a storyboard using prompts. This way the students quickly get to know how to take and save pictures and videos and to piece them together using movie editing software to create an outcome that can be displayed to others in the class. The incompatibility of technology can cause problems particularly when video taken on the Palm as 3gp is incompatible on some PCs. Software found at sites such as http://www.miksoft.net/mobile3GPconverter.htm can be used to convert the video to compatible avi files.

Mobilizing-Safari – Putting Information Literacy in Your Pocket

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Background

This paper presents a case study of Safari, an online, open-access course designed to improve information literacy skills amongst Open University students. The course was conceived, developed and is maintained by the Library. In 2007 it was 6 years old and in need of re-branding and revision to include online skills, particularly techniques for evaluating web content. During review we considered how and when students used the web resource. Consequently, in addition to a web version, we decided to develop a mobile device edition which, via phone networks, might achieve better and wider access beyond that achieved by the present web version.

Methods

Although not excessively text-heavy, the original content for Safari was not immediately suitable for mobile delivery. Auto-detect and reformat (ADR) technology could render pages for mobile delivery but content was not optimised this way since the process simply reduced page size rather than re-modelling actual content. Instead, web content once revised was reworked into a series of small learning objects based on the principle themes from the original content. These were structured using ADR software developed by Athabasca University for a screen restricted to around 150 characters or a single image with minimal scroll only sufficient to display responses to in-content questions.

Contribution

Currently, in partnership with the Athabasca University Library team, we are working to further enhance the ADR software used. It is now being tested on different devices and platforms including Nokia N95, iPhone, Qtek, Blackbury, Symbian OS, OS X (Safari Web browser) and Windows CE before final modifications are implemented.

The first module is available for evaluation via the OULibrary website: (http://digilab.open.ac.uk/testarea/mobileSafari/index.php). Other modules will follow shortly. In addition to using the material as a stand along resource they are also available for embedding in to course materials in, for example, a virtual learning environment or into online assessment guides where they serve as revision aids..

Evaluation and reflection

Many hurdles have been overcome but there are still fundamental issues that remain unresolved – partially at least. The lack of a common platform for mobile devices makes it difficult to optimize the contents for every potential device students may wish to use. Most mobile platforms don't support advanced html features this constrains content. Most current internet tariffs are expensive and speed limited; this means that most users only access text-based contents, or download small chunks of information. What can be displayed is likewise limited by the small screen size on most devices. Equally, all these factors present a challenge in terms of the pedagogy of mobile learning design.

This paper presentation will look both at how the software is structured and at the implications this has for the presentation of content. It will also report on implementation issues, on feedback from users, and will consider suitable criteria for the assessment of success in such a project.

WildKnowledge: a review of using mobile technology to promote outdoor learning

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Background

In 2004, Personal Digital Assistants (PDAs) with integrated GPS functionality became widely available. This marriage of technologies led researchers at Oxford Brookes University to investigate how mobile devices could be used to engage young people in outdoor learning. The research focussed on the creation of wildlife identification keys and recording forms (which include a GPS field) for mobile devices (*WildKey*). This research has ultimately led to the creation of an organisation (WildKnowledge) whose aim is to deliver 'on-location' understanding and to capture data at the point of inspiration. WildKnowledge have developed two further packages: demand for flexible recording tools has led to *WildForm*, whilst the potential of location-based learning has resulted in *WildMap*.

Four years on, this paper examines the potential of mobile learning in promoting outdoor learning. Although much anecdotal data on the advantages of these mobile applications has been gathered, this paper will focus on the *WildKey* application for which most quantitative data exists. This data was acquired as a result of a Heritage Lottery Fund project which involved schoolchildren using mobile technologies in biological fieldwork.

Methods

Schoolchildren took part in wildlife identification workshops in which they used *WildKey* software on PDAs at various field sites. The software provides a series of simple, image-led prompts via which users progress through a multi-access branching database.

Questionnaires asked children to identify common species and answer a series of questions in order to assess what they had learnt and what they thought of the experience. Questionnaires were also used to gauge teachers' opinions on their students' learning.

Contribution

From April 2006 – April 2007, 1163 people took part in 47 workshops. The workshops included 937 pupils and 226 teachers and other adults. Data from the workshops was uploaded to a central database and mapped in Google Earth. The maps were published so participants could view records.

Evaluation

The potential of mobile devices to encourage children in outdoor learning was well illustrated. A 170% increase in correct identifications at the end of the workshop compared to the beginning was recorded. For children who took part in two consecutive workshops, a 378% increase was recorded. 92% of pupils said they enjoyed using the handhelds to identify wildlife; 81% said they found *WildKey* easy to use. Teachers' responses were overwhelmingly positive. 100% believed the experience was worthwhile and that the handheld computers motivated their pupils.

Reflection

This paper does not provide scientifically robust data in terms of a comparison of a mobile learning group *vs*. groups using traditional techniques. However, the results show an impressively positive response to the use of mobile devices in outdoor education. Ideally further research should be undertaken which could extend to other WildKnowledge applications to compare:

- quantity and quality of data collated using *WildForm vs.* a pen-and-paper based survey;
- levels of learning attained with the multimedia based *WildMap vs.* a traditional audio tour.

This is currently beyond the scope of WildKnowledge but could present an opportunity for an interested academic institution.

Time to Engage? Texting to Support and Enhance First Year Undergraduate Learning

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ABSTRACT

The latest generation of undergraduates live and have grown up in a highly connected world which, it is claimed, causes them to develop fundamentally different ways of thinking and information processing from their predecessors. Of increasing interest are mobile learning (m-learning) opportunities, which may offer alternative or complementary modes of learning that more closely match these students' preferences. Many pilot or demonstrator (proof of concept) m-learning projects have illuminated the potential for mobile devices to support learning and change in HE approaches. Typically these might involve the use of high specification devices running specialist software packages and/or focus on using mobile devices as part of highly student centred learning experiences located remote from more traditional learning contexts. Few studies have explored how to harness existing infrastructures of personal mobile devices or the protocols of social communication for academic purposes. Furthermore, little is known about how mobile mediated communication might compliment more traditional learning and teaching contexts (e.g. lectures, seminars and more recently and increasingly, Virtual Learning Environments (VLEs)).

This paper seeks to add knowledge in these areas by reporting and reflecting on a case study which investigates how the academic and personal development of first year students (n=81) on an undergraduate sports education degree can be supported and enhanced by m-learning. Drawing on Moore's theory of transactional distance we aimed to reduce the 'distance' between tutor and students and students and the course content. More specifically, by structuring inter-session study time using group learning activities we sought to establish learning networks that more effectively support the student experience on a core unit of study. In addition, we sought to harness the communication cultures and skills of these 'digital native' students, using mobile phones and SMS.

We review findings from a student survey about the extent of mobile phone ownership, the capability of the devices, the range of contracts, and student views about the potential use of their phones as tools for learning. The survey informed the initial design of a set of group learning activities giving structure to out-of-session study while facilitating greater connectivity between the students and their course, and between the students and the tutor. Asynchronous tools (forums and wikis) in the VLE were used in concert with mobile communication, managed through a texting management service. We report on the outcomes of our formative and summative evaluations which yielded both qualitative and quantitative data from a variety of sources: focus groups, an online discussion forum, student questionnaire, access statistics from the Moodle VLE and texting management service, and the tutor's reflective journal.

We discuss our early findings linked to the outcomes of our evaluation, and specifically three issues: how texting can support student time management; how the SMS communication can extend the tutor's voice; and to what extent we were successful in appropriating students' personal mobile communication infrastructures. Finally we discuss how this study addresses some of the challenges associated with the perceived increase in transactional distance caused by physical, cognitive and digital remoteness between students and their teachers.

Keywords SMS, mobile phones, student transition, conversational framework

An Ontology Based Learning Architecture

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ABSTRACT

The Department of Information Systems at the Corvinus University of Budapest together with the Corvinno Technology Transfer Center has a leader position in Hungary in introducing mobile learning into the mainstream education. The first developments have started five years ago and since then the department participates continuously in European research consortiums, dealing with various segments of mobile learning. After several years of collecting expertise, developing trial content and methodology for mobilized course delivery, this distribution channel became mature enough to support learning activities of the students of Corvinus University in the academic year 2006-2007. Starting from the spring semester more than 3000 students can reach and use mobilized learning content with their mobile devices.

The core element of the service portfolio is the F2F education. The scope of curricula taught in our training programs is represented by the recently developed educational ontology, which is going to be the domain of future content development as well. On the top of traditional classroom teaching a Virtual Learning Environment (VLE) supports individual learning, enabling the use of even rather different independent learning styles. A Hungarian Learning Management System (LMS - CooSpace) provides authentication and other community services related to course organization. Further important service-modules, like adaptive testing, are connected to this platform as well. Mobile lear-ning infrastructure, as an enhancement of the VLE, adds flexibility to the system, where individual learners are not bound to a certain location or time anymore, however the content is still connected to the traditional lectures and seminars. At this moment, the following services support our mobile learners:

- Adaptive self assessment. An ontology based tool helps students to discover their gaps in their factual knowledge, when they prepare for an exam.
- Tailored on-line course contents for mobile phones (lecture notes, lecture and seminar summaries, glossaries)
- Enabling to download all course contents to their mobile devices
- Using mobile-forums, an on-line, real time feedback is provided for the teachers during the lectures. Students can ask their questions, indicate their difficulties, problems with their mobile phones.

To measure the impact of mLearning a focus course has been selected. 650 Business BSc students have to take Business Informatics as a compulsory course at the Corvinus University of Budapest. This programme is a regular face-to-face programme, meaning that the knowledge transfer initiated in classrooms. The technology behind supports blended learning activities through the complete learning cycle:

At the end of the course 244 students filled out our questionnaire, concentrating on the usage of our mobile learning services. The results and the outcome of this massive usage is presented.

Keywords: mLearning, mobile LMS, content development, ontology, higher education

Understanding Mobile Learning at a Canadian University Through MobiGlam (UMLAUT-M)

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ABSTRACT

This mobile project was designed to measure the potential impact and uptake of mobile learning by students at a Canadian distance education university. Respondents installed a client-side mobile application, MobiGlam, onto their devices, through which they accessed a Moodle course. Respondents were given pre- and post-questionnaires designed to measure the usability, networking capacity, and the constructivist learning potential of the system. This presentation discusses the most salient results.

KEYWORDS
Mobile learning, MobiGlam, Moodle, Canadian mobile readiness

INTRODUCTION
The goal of the UMLAUT-M project was to investigate the viability and usefulness of mobile access to online course materials. The project was conducted at a distance University in Canada. Although, there is some provision for interaction through various electronic tools, there remains limited "connectedness" among learners. To enable flexible and potentially more frequent mobile interaction, the project used a client-side application called MobiGlam. MobiGlam allows Moodle access through any Java-enabled mobile device.

THEORETICAL BACKGROUND
The researchers used the FRAME model as the theoretical base for the project. Set within a context of information, the FRAME model defines mobile learning as a balance between device, learner, and social aspects (Koole, 2006). In a "balanced" mobile environment, this convergence should result in an environment permitting enhanced networking and problem solving. Using this model, the researchers hoped to assess the quality of the mobile experience.

METHODS
The participants were graduate students in an Master of Education program. To emulate realistic conditions, participants were free to use any Java-enabled device they wished so long as they could connect to the Internet. The participants were asked to complete a pre-questionnaire designed to determine their experience and comfort levels with Moodle and online learning. After one-month, the participants were asked to complete a post-questionnaire regarding their experience with mobile access to Moodle. Questions of both questionnaires were structured according to the FRAME model.

CONCLUSIONS
Preliminary data from the project suggests that some students and the Canadian telecommunications industry may not be ready to fully implement mobile learning. The researchers had difficulties with locating cost-effective SMS gateways in Canada. Further, many of the respondents had never before "texted" a message nor accessed the browser on their mobile devices. Hence, perceptions of usability were lower than expected. Several respondents had difficulties because they were unfamiliar with the browser and SMS functions of their devices. The respondents indicated that mobile access was not important to them, nor would it significantly affect their communication patterns, learning strategies, or motivation. Ratings for usability, networking, and potential educational benefits were generally low. *Yet*, respondents were in favor of institutional provision of SMS notifications and mobile access. Age and culture may have had an impact upon acceptance levels.

Mobile Learning Foresight:

The Future of Learning

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ABSTRACT

The purpose of this research is to examine the current state of mobile learning practices and provide foresight into the potential adoption and future utilization of mobile learning practices within formal and informal learning contexts. As a result, this short paper will share the insights and results that have developed from a doctoral study, which is currently in progress. Hence, this short paper will give account that research being conducted shows that the future of learning is already here, it is increasingly becoming more mobile and that the innovative mobile technologies, services and practices associated with shaping how we learn now and in the future are not evenly distributed.

Author Keywords

Education, learning, mobility, mobile-learning

BACKGROUND

The purpose of this research is to examine the present state of education and mobile learning and provide an empirically sound forecast of possible mobile-learning scenarios that are emerging within the time frame of 2015. Furthermore, the research conducted will examine the theoretical foundations supporting the emergence, adoption and proliferation of mobile learning scenarios and examine how the emergence of a pervasive learning culture is inevitable within the context of ubiquitous computing. The intended audience of this research will be individual learners, educational practitioners and policy makers, to equip these stakeholders with the intelligence to prepare for the emerging future of mobile and pervasive learning.

METHODS

The doctoral study presented is a form of action research, in which an iterative inquiry process is employed within a collaborative context to help ascertain and predict potential future mobile and pervasive learning scenarios. This study seeks informed opinion and knowledge through a systematic, interactive forecasting method. This method will be based upon a hybrid form of "Delphi-study" coupled with virtual focus groups and semi-structured interviews. This hybrid methodology has been chosen in order to obtain a highly nuanced and granular perspective from a panel of carefully selected independent experts in order to gain the most accurate depiction of the possible future of learning.

CONTRIBUTION

The intention of this study is to make a positive and worthy contribution to the emerging mobile-learning research corpus. Furthermore, this research will make a contribution to enhancing the capabilities of individual learners, and will equip educational practitioners and policy makers with the intelligence to help shape the future of how education is conducted with in the context of mobile learning.

EVALUATION / REFLECTION / PRESENTATION

In conjunction with the empirical study a comprehensive evaluation and critical appraisal of related mobile-learning research and related studies has been proposed. Moreover, a critical analysis of the empirical study will be made in order to reflect on the outcomes of this work in order to inform future studies of a similar measure in order to garner the greatest knowledge possible to help forecast the future of learning. In doing so, it is the hope that the research conducted will make a worthy contribution to helping shape the future of learning and help securely establish and embed mobile-learning scenarios within our societies.

The results presented in this short paper give account that the research conducted for this doctoral study highlighted conclusively demonstrates that the future of learning is already here, it is increasingly becoming more mobile and that the innovative mobile technologies, services and practices associated with shaping how we learn now and in the future are not evenly distributed.

Mobile Mathematics – Lessons Learnt

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ABSTRACT

This paper links up with research presented at a previous mLearn conference regarding a specific attempt (MOBI) to address some of the challenges posed to mathematics education in the South African landscape within the framework of Action Research. MOBI is a J2ME (Java) applet which, once downloaded onto a mobile phone, allows users to listen to podcasts, view multimedia content or even chat to other users via instant messaging on a Jabber platform as long as they have an account with data connectivity. The MOBI platform has limited interactivity in that it keeps track of what users have previously accessed, allows them to restart previous sessions and in addition, offers an assessment tool with a corrective component. Although the platform allows for almost any kind of content delivery, the initial aim is to deliver mathematics learning content for grades 10-12 which is aligned to the Revised National Curriculum of South Africa. Learners are able to access learning content in various ways, including a "Quick Find" option which is basically a keyword search. This particular study will focus specifically on insights gained from the "evaluation" and "reflection" phases of the AR cycle and to show to what extent these have contributed (or will contribute) to changes to be implemented in the first full release of MOBI, which is due by June/July 2008.

The "evaluation" phase basically tries to answer the question – "whether the theoretical effects of MOBI were realised – i.e. did it work?". In a technical sense the MOBI solution is a success beyond most other mobile solutions in that it is able to work on a number of "ordinary" phone makes and models. Related to this is the fact that, despite the limitations of screen size and bandwidth issues, it was possible to deliver, if not an exceptional, at least a satisfactory user experience. Exceptions in this regard were the "settings" menu as well as the search user interface: Other than using the "Quick Find" option, users had difficulty navigating the menu system, which was perceived as cumbersome. Users had difficulty understanding a menu system based on Outcomes and Assessment criteria. This ties in with a more critical issue in that, from an educational perspective, only limited success could be achieved. Although more than 1000 users have downloaded MOBI to date, this has not yet translated into consistent usage of the platform on a daily or even weekly basis by these users, with usage being ad-hoc rather than regular. Interviews with users as well as research into usage patterns revealed that using the South African national curriculum as the "context" for mathematics learning delivery simply was not sufficient, even though all content was indexed to a high level of detail. Learner requirements are related much more to their specific handbooks, and even though a search for a specific mathematical term would bring them the same information, they seem to still prefer a solution which relates to specific exercises in their handbooks. From the "reflection" perspective, interesting practical outcomes have followed from the alpha and beta phases of the MOBI implementation. First, it was shown to be technically possible to create a mobile learning platform which is model "agnostic", and which works on ordinary mobiles issued to users as part of normal contracts by the mobile providers. In an environment where J2ME standardisation still has a way to go, this was quite encouraging, especially with JSR-248 only in early stages of adoption. Second, the quick adoption of MOBI by a number of users even with limited "advertising" shows that there is a real need for a mobile solution like MOBI. Lastly, some important lessons were learnt in terms of the educational value of an application like this. The most important of these is that although learners are quite willing to adopt a mobile technology as a tool to enhance learning, they will have problems using it on a consistent basis, if it is not *directly* integrated into their *immediate* learning environment. In other words, even though the content is perfectly local, users do not find enough value in a solution where they have to make the jump from their own handbooks to the support content (MOBI). (This is supported by the use of MOBI in a local mathematics Olympiad) Important lessons were also learned in as far as the MOBI user interface is concerned. The reflection phase of the current project indicates that there is enough promise in the MOBI project to warrant a further AR cycle which will focus specifically at finding ways in which to integrate the existing and future MOBI learning content with learners' everyday learning environments. These will probably include ways in which to enable teachers to seamlessly submit their own learning objects to the MOBI platform for access by their learners. Special attention will also be given to improving and simplifying the user interface and menu system.

Reaching Learners Through Mobiles

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Abstract

There are approx 2 billion teachers and learners of English in the world. If learning content is to be relevant to the lifestyles of digital natives, it has to be delivered via technology. Work carried by David Graddol "English Next"[1] for the British Council indicating that we are in a new phase of English development, and that work carried out by David Traxler[2] in Africa demonstrates the potential for learning with mobile devices. With the proliferation of mobile devices[3], there is the opportunity to create new streams of learning and by using the technology in hand; English learning can be delivered to those without the opportunity of face to face teacher contact.

The British Council has engaged in research into the practical use of mobile devices for English learning in and out of the classroom with a range of mobile technologies from SMS to rich learning content.

Methods

The British Council piloted various learning products around its global network to test out learners' responses to using low tech, mid tech and high tech devices for English learning. Qualitative data through questionnaires and focus groups was collected along with quantitative analysis of uptake and feedback.

Contribution:

The British Council has carried out pilot studies in Hong Kong, Thailand, Milan and Valencia. The methods of delivery included SMS messages, SMS quizzes, Java Games, Interactive Stories and Flash learning content. The number of participants involved in the pilots ranged from 20,000 in Thailand to 26 in Valencia.

Evaluation:

The pilots have demonstrated that there is a market for simple SMS based learning in developing nations and that mid tech and hi tech learning will be viable within the next 2-5 years.

Reflection:

Although the pilots demonstrated a need for English learning globally there are issues surrounding connectivity and access to affordable technology that could impact future developments. We will also reflect upon the influence of smart devices and particularly the I-phone and its user interface in relation to new learning opportunities.

Mobile learning for student support

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Author Keywords
Inclusion, mobile learning, accessibility, study support, skills development, flexible learning.

BACKGROUND

At The Open University (UKOU), Student Services provides learning support for around 200,000 diverse students. The majority of students are studying part-time and have other commitments and calls upon their time. Our open access policy means that our students have a diverse range of support needs. In a mobile world, flexible support resources can be delivered ‘just in time’ to suit the needs of these learners, and in some cases, offer a sense of being part of a community of learners. Our approach fits with social constructivist, learner-centred practice, and m-learning offers learners advantages such as portability and flexibility. These aspects could have a positive effect on student retention.

METHODS, CONTRIBUTION AND EVALUATION

Three inter-related projects have enabled us to improve our existing online resources, which include mobile access and the use of additional media. These online resources adhere to the World Wide Web Consortium (W3C) guidelines, and notably, the majority of the material is available to all through the internet, allowing informal learning opportunities. Really Simple Syndication (RSS) feeds have been implemented to allow subscription to updates.

Firstly, existing learning skills resources were re-structured, re-designed and enhanced as independent ‘chunks’ (learning objects), which are housed at Skills for OU Study www.open.ac.uk/skillsforstudy. These units can be combined flexibly and include guidance, learning-related activities, and video and audio assets, which are categorised into key skills topic areas. In addition, information technology skills development advice includes ideas for using web technologies within study.

Secondly, a group of OU tutors developed alternative mobile-accessible support materials for their students. The tutors chose the appropriate technology to suit their community of students and particular aspects of their course. As a result of this project we have added information about ways to effectively use mobile devices for learning, and to show how to use and record audio. Further material has been included to inform other tutors about how and when to use such technologies in their teaching.

Finally, a student cohort on a psychology course was invited to take part in a ‘just in time’ texting pilot. 450 students (10% of the course) signed up to receive 20 messages over 26 weeks, based on key points within the course structure. These ranged from reminders about tutorials and assignments to suggestions about making effective use of course resources. Student responses to this initiative have been very positive, and we are looking ahead for sustainable methods for delivering texting based support, as part of our blended provision.

REFLECTION

While the findings of the projects have been both interesting and illuminating, and have resulted in improvements to student support, we need to move beyond projects, which highlights a number of issues relating to

- realising a holistic provision
- making the generic feel personalised
- scalability and sustainability for the UKOU.

Cost-Effective Production of Lecture Podcasts

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ABSTRACT

This paper argues that attendances at all kinds of timetabled events in educational establishments are a particular concern – even those students who are committed to the course do not feel it is important to attend at the levels of a generation before- so that there is a demand for every presentation which a student may have not attended to be available for their “offline” perusal, and an unwillingness of the consumer to accept that the institution should not make it possible for the staff to achieve this.

It is argued that ”traditional” methods of production of videos of lecture presentations - “Studio quality” utilising professional AV technicians, auditorium-fitted “Web-Based Lecture technologies” (WBLT) by such companies as ECHO360 (previously Lectopia/Apreso) - are suitable only for a limited number of presentations due to the high cost of fit-out, capture and post-production. However it is our contention that it is possible to make every presentation of every class available as a podcast by utilising low-cost technologies and applications.

For a simple presentation, a free tool “PowerPoint Producer” will produce an HTML slideshow from a PPT file which has had the “rehearse timings” option used.. For more complex presentations (e.g. demonstrations of spreadsheets, etc) the screen can be captured, either using special devices (capture cards, possibly a full capture station) or with software-only applications such as CamStudio. If it is desired that the presenter is also to be seen, then the quality and useability of camcorders are easily good enough for capturing the limited quality (pixel count) required for podcasts.

With several elements, the post-processing of a 1-hour lecture took 2 full days for an AV editing technician to produce. This can be avoided, for example the author has produced an application “LectureShow” which puts both elements together and produces a file suitable for remote viewing, again using screen capture methods. This application allowed a total of only 10 minutes to be spent in post-production per hour of presentation.

Was it worth even that amount of effort? The author has now archived a full year of lecture presentations averaging 6 hours per week. 230 students were contacted and the evidence produced was overwhelmingly positive. Not a single person could be found who had not watched some of the recordings. None of them had any comment about the quality not being “studio” standard. Interestingly there were a few comments that they lecturer was actually clearer since they were attempting to ensure a good recording with fewer “umms, ahhs and mistakes”.

Several other lecturers were persuaded to join the pilot. None of them had any difficulty in recording the material, and all were satisfied with the files returned to them after post-processing, and did use them in their teaching – one sent copies on CD to a collaborative course in the middle-east. Several have returned to use the system again.

In summary – It does no harm, it helps some, it costs little, it is easy to use, and it is commended to you all.

Strategies for Enabling Mobile Learning in the Secondary Phase

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ABSTRACT

Nationally, the successful implementation of mobile learning within secondary schools has been problematic. Children do not stay in the same groups and see different teachers, which can lead to inconsistent use of the technology. In Wolverhampton a new approach has been piloted which has made a huge difference to the use of mobile learning technology within the secondary classroom.

To support the development of mobile learning within secondary classrooms, teacher training takes place within the school as part of an after school session and involves all staff with a role in its use, including teachers, senior managers, support staff and technicians. Each training session is focussed around a piece of generic software that has a broad application across the curriculum, thus giving pupils the opportunity to use their knowledge at a time that best suits their learning. This method also allows teachers to focus on one aspect of the technology at a time, thus avoiding overload; as a consequence staff feel that they are in control and are happy to embrace the technology. Training sessions are quickly (within a week) followed by team teaching in which the E-Learning Consultant and the class teacher form a partnership to deliver the lesson. The children are shown how to use the software by the consultant (simultaneously reinforcing the teacher's knowledge) then pupils complete the curriculum task using the technology. The E-Learning Consultant remains within the classroom and provides any technical reassurance that may be needed. This method is particularly successful as the software can be used across the curriculum by teachers in different departments and therefore, the software becomes an integral part of teaching and learning within the school.

This method has been very successful in Wolverhampton and is currently being rolled out across all participating secondary schools. It could hold the key to the successful implementation of mobile learning into the secondary school curriculum nationally and beyond. Pupils like this way of learning how to use their device as reinforcement is built in and they can choose to use the application whenever they wish. Teachers prefer this type of support, as the software becomes an integral part of the curriculum to be used by all staff in support of pupils' learning. Both teachers and pupils move forward together, providing a secure transition to fully integrated technology.

Mobile learning can be effectively implemented within the secondary school phase, but it requires structures to be in place centrally to succeed. This presentation will explain how this can be achieved.

From VLE to iPod to Phone - Mobile Learning Delivery in Action, Supporting Vocational Education.

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Background

Application of mobile telephone short message service (SMS) and podcast (video and audio media) technologies to deliver discreet learning modules direct to learners own devices and to institutional virtual learning environments (VLE's). Our experience in delivering to a variety of courses and levels.

Methods

Using an SMS service linked to a podcasting server by RSS feed technology. A podcast is an audio or video file that has a 'wrapper' around it that helps it be read automatically – like a new piece of news in a news feed. A new podcast entry triggers the release of an SMS message. This message contains the web address of the podcast material. A web enabled phone can then download that material directly. Non web enabled phones get a SMS message serves as a reminder that new material is available either to view online or to download. This material is also available via a podcast aggregator such as Apple's iTunes. From here a student can load the material onto other mobile devices such as iPods.

Using the same RSS feed we can place the podcast directly into the institutions VLE. This allows the material to be accessed in a variety of ways to ensure inclusiveness.

Contribution

The College has put these technologies in place and they are in use with staff and students. Work has been carried out with a partner College and a partner school for sharing digital podcast resources supporting engineering under the auspices of a MOLEnet project. Under a Learning and Skills Council project the same technology is being used to support the special needs agenda of learning for living and work. For lifelong learning we are also sharing graphic design resources. Supporting the 'young apprentice' scheme we have handed out data enabled mobiles to download SMS and to media as a trial group.

Evaluation

A full evaluation has not taken place yet. This will be as part of the MOLEnet and Learning for Living for Work projects. However we have had plenty of experience for reflection.

Reflection

We have had these technologies working reliably for over a year and have tested out different elements with staff and students and have had feedback on the impact.

We have technological considerations such as file formats for audio and video and the setup of podcast servers. We also have experienced some of the concerns that would affect our users such as high mobile data download costs. In setting up projects where we have purchased mobile devices we have come across restrictive mobile phone contracts that do not give us the flexibility we require to pay for data and allow students to make calls. We have much to share on variety of devices and solutions and this will be a key part of our presentation.

A Reflective Account of the Implementation of Podcasts on a Level One University Computing Course

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ABSTRACT

This paper considers podcasting in the context of distance education students and specifically Open University adult learners.

Podcasting has revitalised interest in the use of audio in education and its pedagogical value, and there has been significant implementation of podcasts in university courses over the past three years. There is a growing body of research evidencing the use of podcasting in a number of applications including: lecture recording, pre-class listening material, extended course material, and student feedback and support. Whilst the body of literature is growing, cognisance is given to the need for further research in this area. In the university sector, the adoption of podcasts as a means of pedagogy has been significant and notable examples can be found in the USA at Duke, Stanford, California and Berkley universities and at Charles Sturt University in Australia. In the UK, the IMPALA project at the University of Leicester is the leading podcasting research project in the UK.

We are presently involved in producing complementary/remedial podcasts/vodcasts for approximately 1500 first level distance education students studying the Open University course, M150 Data, Computing and Information. Podcasts are made available via the course website for students to download to support their study of JavaScript programming and are also used as a teaching aid for tutors to support them on this challenging part of the course.

We have also begun a local experiment with a small group (11) M150 students and here, podcasts are offered before and after tutor marked assignments (TMAs) as well as to publicise course events.

The research questions relating to these podcasts are: 1. do the podcasts increase flexibility for the learner? 2. Is anxiety and isolation reduced? 3. Are they effective as a supplementary teaching tool and, 4. Does audio have specific benefits for learning?

The success of the local podcast series' will be measured by open-ended interview sessions with students whilst the national podcast series' will concentrate on course tutors. Here, tutors will be invited to complete an online survey followed by a small focus group to gain more issue exploration and greater understanding.

The over-arching aim of this research project is to measure the effectiveness of podcasting in relation to student learning. Presentation of the results of the empirical research will provide a timely contribution in the use of this mobile learning technology in distance education. Results will be presented visually by means of a number of quantitative charts whilst qualitative results will be analysed and presented in a thematic way.

A Trip Down Memory Lane: Using Mobile Devices to Capture Transformative Learning

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INTRODUCTION

Images have the power to enable us to express feelings when words are not sufficient; they can be powerful tools of recollection and can evoke memories of emotions attached to people, places and events. The power of images and the ability of mobile devices to capture these memories was utlilised, within the undergraduate medical curriculum at the University of Leeds, as part of the JISC funded Enhancing Learner Progression 2 project (ELP2):

We will highlight points for future discussion and describe how the work is being taken forward into the next academic year

METHODOLOGY

All of the 242 first year students on the medical degree (MBChB) would create a digital story of their first patient visit focussing on their feelings, before, during and after the experience. A sub-group of 12 students were provided with PDAs. Students were asked to use the Leeds University blogging area, LeedsBlogs, created on the ELGG platform, to upload their photographs and share the representation of this photograph with another student. The completed stories were created using PowerPoint and shared with their tutor group of approximately 15 students.

The stories were not assessed but each student received feedback from their peers after their presentation.

The study is currently being evaluated but data so far received from the sub-group of 12 students, through a focus group, has highlighted the power of the mobile device to enable students to take pictures at the moment of activity and to then use these pictures to rewrite, reorganise and repurpose their stories.

FINDINGS

The students' experience highlights the process of reflective story creation through the use of everyday technology. Through the taking of pictures the technology provides a means to record the 'here and now' and provides a visual artefact for future reflection.

The PDAs were an extension of the students' normal use of technology. The ubiquity of mobile devices and the students' knowledge of their use can be harnessed to encourage students to use pictures to chart their experiences and then further utilised, with direction, to focus on one particular learning task.

The experience of the exercise points to a transformative learning experience as articulated by Jack Mezirow (1991). The taking of the pictures of the experience and the subsequent creation of the story triggered a 'disorientating dilemma' (Mezirow 1991), the sharing of these pictures, through the blogging platform and face to face, and the associated emotions or story associated with the images create an arena for discussion and critical reflection.

The viewing of stories was just as important to students as the creation. Does the use of pictures help to create the environment necessary for communicative action as outlined by Habermas (1987)? Do students feel more able to discuss their feelings and experiences through the medium of the visual? How can tutors create the physical environment necessary for stories to be shared?

How can digital stories be assessed? Will quality override actual content and what is being said? Can existing rubrics be adapted?

FUTURE WORK

The findings of this pilot have fed into the work being carried out by the JISC-funded Reflect 2.0 project at Leeds and Leeds Metropolitan Universities. A further group of 12 medical and 34 Dietetics students will be provided with PDAs. These PDAs will also enable students to carry out mobile assessments and the evaluation of this project will enable a more holistic view of the student use of mobile devices in professional education to be explored

Art Mobile: a New Experience in the Fruition of the Artistic Patrimony

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ABSTRACT

This paper focuses on an experience on the application of new mobile technologies for artistic training and territorial tourist promotion.

BACKGROUND

The art object can have at least two kinds of relationships in technology use: artistic expression and communication instruments involving more public through informal learning. Our research focuses on the creation of Art Mobile (AM), a mobile guide for Saint Ambrogio's Church, Milan. The theoretical reference areas for the application development are: mobile learning, learning objects (LO) theory, the study of art from an iconological analysis by Panofsky (1999) and the aesthetic experience by Goodman (1998) and the analysis of the "visual text" with a semiotic structural matrix.

METHOD

The educational research methodology for AM is the LO applied to mobile instruments.

CONTRIBUTION

Principal objectives are: - contents diffusion for artistic and environmental patrimony; - reinforcement of art history in schools or individual enrichment; - enrichment of the cultural visit. AM, in the prototype phase, was tested on 26 subjects, students from 22 to 27. All received a Pocket PC with the AM application. Experiences lasted on average 14 minutes, from 5 to 20 minutes. Afterwards a survey using a questionnaire evaluated the experience. From the "practical" aspect particular technical difficulties were not found: using AM was easy (84%), comprehension of the icons was easy/very easy (92%), the program's graphic interface was intuitive/very intuitive (96.2%) and sound was adequate (88.5%). Regarding the contents it was found that: technical quality of the images was adequate/very adequate, contents organization was clear/very clear, information quantity was sufficiently rich for most subjects, "rich/very rich" (34.6%), not rich enough (25%) and language used was "understandable" by everyone.

EVALUATION/REFLECTION

Positive aspects: - contents: simple and intuitive fruition, clear explanations, conciseness; intrinsic characteristics of the technological instrument: practical, easy to use; - sense of liberty using the mobile device and of AM guarantees: in movement, time, in the fruition pathways. Negative aspects: - contents sometimes were not exhaustive: too shallow, not very original (more curiosities and details were requested); - distraction made by the device, with technical problems of the application or device; - distractions made by the technology and device, sometimes not well run; in the fruition modality some lack of interaction was observed and individualism of the experience.

CONCLUSION

The test with AM using a mobile guide for the fruition of a cultural resource can enhance and improve the guide. Overall, the test gave very satisfactory results and indications of some tendencies: - users, at least younger ones, are ready for innovative instruments for the fruition of cultural patrimony; - the mobile device solution appears innovative and meets with public approval; - a desire for knowledge emerged, understood by the general request for more information about Saint Ambrogio's Church. It is necessary to follow with the test phase, broadening the sampling: by possibly making a casual sampling of the Saint Ambrogio Church visitors using AM, or experimenting on groups of fairly numerous Church visitors, for example: schools or organized groups, adults and the elderly.

Lilies laze about in the Garden, but there's 'Panda'monium at the Zoo.

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ABSTRACT

Providing immersive, situated learning to field based zoo and botanical gardens staff using mobile learning techniques and mobile devices with Bluetooth and wireless connectivity.

'Lilies in the garden, Pandas in the zoo,

Why don't you come and play with them, and bring your mobile too.'

Whilst not quite child's play, learning about plants and animals in zoos and botanical gardens may soon be as simple as playing along using a mobile phone. Take the following examples:

Wang Wang and Funi, pandas from China are heading for the Adelaide Zoo. Their visit is all about love, and sex, and hopefully offspring: all the while under the intent gaze of tens of thousands of people. The pandas present some pleasant dilemmas for the zoo. Firstly, they need to find enormous amounts of bamboo to feed them. Secondly, since pandas outside of China are a great rarity the zoo is gearing up for a huge number of extra visits. This means that zoo staff and volunteers need to be trained to answer the thousands of questions that keen panda observing visitors are likely to ask.

The Adelaide Botanical Gardens face a similar, if less animated problem. They have just built a new glass-house for giant Amazonian water lilies, which have featured at the gardens for almost a hundred years. Visitors to the gardens, and in particular the lilies have many questions they would like answered, preferably by a staff member and in addition to the existing interpretation material.

In order to help develop the skills and knowledge required by staff to handle the additional demands of exhibits, such as the pandas and the lilies, a trial has been established to research the effectiveness of using mobile learning methods, mobile phones and small Bluetooth and wireless networks for connectivity to a central data repository. The aim is that field based staff should be able to update their knowledge and skills whilst they are on-the-job, anywhere, anytime.

This presentation will elaborate on a pilot undertaken at the Adelaide zoo and botanical gardens to help with the staff development required for situations like the pandas and the lilies. Data and information for the required learning is held in a database that can be accessed on demand using either the Bluetooth or wireless connectivity of mobile phones, which keeps the transmission costs to a minimum. Data can also be uploaded to the data base in the field via the mobile phone. A series of surveys (before, during and after) of the learners involved in the pilot program and a series of small focus groups have been used to assess effectiveness in the first instance.

MiLK: Transforming Everyday Places into Dynamic Learning Spaces with Mobile and Web Technologies

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INTRODUCTION

This paper briefly explores how mobile games can transform everyday places into dynamic learning spaces filled with information and inspiration. MiLK The Mobile Learning Kit is offered as a case in point. MiLK fosters creativity and teaches the skills needed for independent knowledge creation and application. The development of these skills in today's students is central a creative, dynamic, and successful future workforce.

MILK THE MOBILE LEARNING KIT

MiLK the Mobile Learning Kit is an authoring tool that allows students and teachers to create and play scavenger hunt style games that lead people through places with the use of a mobile phone. MiLK is designed on the premise that the social devices and networks that student currently use will become increasingly part of their professional lives.

MiLK appropriates popular language, tools and services of games and social networks which support content creation, group discussion, individual reflection, profile building. MiLK can be customised to most classroom scenarios and provides opportunities to enhance learning in many subject areas such as Art, Social Science, Biology and English. Some teachers have used all of the web and mobile components while other teachers have chosen to design activities with single tools such either simple SMS questionnaires or discussion forums for homework activities.

NEW LEARNING SPACES

MiLK employs mobile and web technologies and games to transform everyday places into dynamic learning spaces. The mobile nature of MiLK allows teachers to situate learning beyond the traditional classroom. MiLK games ask students to explore and investigate locales, revealing embedded and sometimes hidden information and knowledge. As such MiLK assists in creating a reciprocal relationship between formal and informal learning, transforming students' relationships to learning and everyday places.

MAKING LEARNING FUN

MiLK motivates and inspires students to engage in learning by employing game design and game play as tools for learning and by framing students as active constructors of knowledge. By framing students as authors MiLK becomes an effective tool for promoting personalised learning. When students make games with MiLK they take control over their own learning and set up structures for others to enquire and investigate. Importantly the game design process requires iterative cycles of creation, reflection, and revision and teaches skills for independent knowledge generation and application.

The motivation inherent in playing and creating games for others evokes a natural desire for students to engage in learning. Results from user trials have indicated high levels of engagement amongst students when learning with MiLK. Significantly reluctant learners and students with learning disabilities such as Asperger's have displayed increased engagement and greater on-task behaviour. Furthermore user trials have shown that when learning with MiLK it is common for students to naturally engage in self-assessment and peer-assessment without being prompted to do so.

CONCLUSION

By facilitating learning activities that motivate students to learn independently and transform their relationships to learning and everyday places MiLK teaches essential skills required of a creative and dynamic 21 Century workforce. Our presentation will validate and further discuss topics raised in this paper by presenting research findings from user trials conducted with students and teachers in locales within and beyond the classroom. – www.milkit.com.au

Utilising Mobile Learning to Engage Hard to Reach Children & Young People

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Background

The paper presents the significant work in Wolverhampton to engage mainstream pupils in learning via the successful Learning2Go initiative. Building on the success of that work and capitalising on the Government's computers for pupils initiative, aimed at ICT provision and access for learners in the most deprived areas of the City, Wolverhampton has now targeted looked after children (LAC) and gypsy / traveller children to maximise the learning opportunity that mobile access and on-line learning platforms can provide.

Contribution

Wolverhampton Local Authority has partnered with o2 to provide looked after children for whom the LA is the legal parent and gypsy / traveller children, with an HTC handheld computer and two years access to the Internet via the o2 network secured under Project Shield. Project Shield is o2's filtered Internet service aimed specifically at protecting children and young people. In addition, the LA, using its learning platform has created an on-line community known as u-Connect. The community will be a safe place for children to access information about the equipment they have been provided with, find help and advice, share information with other children involved, download updates, take part in regular challenges, feedback their experiences, learn about u-Connect developments etc. u-Connect will also have integrated into it a secure social networking environment called Gold Star Café. The purpose of u-Connect is allow the LA to track and monitor the progress of its members in terms of use of the devices and impact on learning. The u-Connect on-line community and its associated activities will integrate learning tasks and objectives subtly so as not to appear as a rigid educational environment. The group of children and young people that this work is focussing on, by the very nature of them being traditionally difficult to engage with educationally, must have at its heart enjoyment whilst at the same time providing the opportunity to achieve.

Evaluation

The LA has commissioned an independent consultant to evaluate how the provision of the handhelds, access to the Internet and use of the u-Connect community is impacting on learner outcomes, motivation and engagement. Coupled with the growing body of evidence already gathered within the main Learning2Go initiative, this piece of work will be critical in providing evidence to support how mobility can improve learner outcomes for those groups that are hardest to reach. The evaluation process will be iterative to allow the LA the opportunity to learn from evidence gathered and continue to push the boundaries mobility can offer. The paper will present a review of current progress, and an outline of the achievements so far.

How do people use Twitter and why do we need to know?

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ABSTRACT

Twitter is currently the technology riding high in the popularity stakes. In terms of the Gartner Hype Cycle, then we are moving towards the 'peak of inflated expectations'. Twitter enables short text based blogging and communication between people in a very easy and intuitive way. It adopts low threshold technologies and places the individual in control. An educational scenario for twitter would be; Student Bob seats in cafe reading the Metro (free newspaper widely distributed in the UK). He comes across an article that he connects to something discussed in a lecture a few weeks ago. So he updates his twitter account with the intention of informing others. Student Jane is getting onto a bus. She picks up the Metro from the front and sits down. During the journey she receives a SMS notification from Student Bob's twitter account. She reads the article, but interprets it differently. However she's not confident about her interpretation so she phones a friend. After which, she takes the plunge and challenges Student Bob's interpretation through her twitter status. The scenario is very appealing and it offers some powerful learning outcomes. However, is it realistic? To help answer this question we'd need to know,* How are people currently using Twitter?

- What is shaping this pattern?
- How is their use evolving over time?
- What role do people think twitter offers as a learning technology?

The presentation addresses these questions based on the findings of an online survey and selected interviews. The respondents characteristics include they all work in UK Education, they are a relatively experienced in using twitter and have well established social networks. The initial key findings suggest that most people use a combination of different approaches to access their twitter accounts. However, the primary method for the largest number of people is the web site (36%). In mobile related patterns then the majority (64%) of people didn't use SMS notification. For those who did then there appeared to be two broad strategies. People either toggled it on/off depending on their location, or they selected a few people to follow via SMS notification. A large number of responses reported they integrated twitter with other software, including personal blogs and Facebook. The rationale being offered was efficiency gains and widening the audience. However, some people started to question if it did add value. There appears to be a conflict between the social network and reflective blogging aspect. For instance, 82% of respondents were conscious of the different audiences when twittering. A common theme was "there is stuff I can't twitter or say because I wouldn't want it to reach the wrong audience". Overall, these and other findings make an important contribution to the debate. It informs us about people's attitudes to using Twitter and their thoughts on its potential role in education. This is important as a better understanding of these issues will help inform people if Twitter is appropriate and how to implement it in their own teaching and learning.

Author Keywords: Twitter

Web-based Museum Trails: Promises and Pitfalls

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ABSTRACT

Use of mobile learning technology in museums is an emerging field of research. New mobile technologies are giving rise to new conceptions about the depth of learning that can occur in galleries, and possibilities for putting these ideas into practice. However, in the project we report on in this presentation, we find that the technology has only partially lived up to its promises.

The 'iGuides from Streetaccess' project at London's Victoria and Albert (V&A) Museum, involves the development and evaluation of web-based trails which design students in higher education (HE) can use to explore the Museum's collections. The project is supported by the Centre for Excellence in Teaching and Learning through Design (CETLD).

Trail design

Twenty web-based trails have been developed, designed to be accessed on Personal Digital Assistants (PDAs) inside the Museum. These rely on the Museum's wireless network, using streaming technology to offer multimedia interpretation. Unusually for museum handhelds, the trails allow the user to input responses in the form of photos, text and voice recordings. As part of formal education in museums, this technology has to our knowledge only been used with schools, with content restricted to text and images, and input only in the form of text.

The two-way nature of the software supports a dialogue between the learner and the environment. In addition, resource development expertise, combined with the capacities of the technology, opens up new possibilities for pooling insights from museums and HE institutions.

Evaluation Method

The evaluation used qualitative research techniques. Students were accompanied by a researcher as they undertook their trail, who observed what they experienced and on occasion prompted them to describe what they were looking at. Students also took part in a post-trail interview where they were asked a series of questions about their experience. Data was analysed using a combination of concept identification and re-reading of data.

Findings

Students' responses to the content were broadly positive; they valued listening to views from different people about the same object, including in some cases those of their peers. While some students also found the handhelds exciting to use, responses to the PDA as a device were generally less positive. Students found that using the PDA could distract them from objects in the galleries and were sometimes cumbersome to use. In addition, we have found that connectivity is not yet reliable enough to offer the trails as part of the V&A's education service.

Such materials may have an important role to play in the higher education learning 'landscape' where tutor time per student is falling and where self-directed learning and independent research skills are becoming more important. This project suggests areas of content and technology development which could support this role.

Trails can be found at: www.streetaccess.co.uk/vandacetld.html. Choose a trail from the menu and click 'preview trail'.

Developing the use of Quick Response (QR) bar codes in Teaching and Learning at the University of Bath

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ABSTRACT
QR (Quick Response) codes are two-dimensional bar codes which store small amounts of encoded data that can be read using a mobile camera phone. With the ability to store hyperlinks, text, pre-prepared SMS messages and phone numbers, QR codes provide a fast and intuitive means of transferring information from real world media to hand-held device.

At the University of Bath we are experimenting with the use of QR Codes to deliver supporting materials in lectures and within administration. Some user scenarios include, being projected at the start of the lecture enabling students to download the presentation, or they could be used during the session to provide feedback, or for the end of session evaluation. Alternatively, they could enhance the navigation for mobile learners when appended to printouts and course instructions.

Recent developments mean the use of QR codes is becoming more viable in Higher Education. A number of providers are now supplying the QR Readers (decoders) pre-installed on their devices. While, the QR Creator software is becoming more accessible through freely available web services which create a single QR Code image.

However, there still exists a major bottleneck in their use in Higher Education. Currently, the external hosted solutions do not scale for an institutional wide implementation. While, the level of user awareness is still very low. This presentation will describe how we have developed a QR code creation service that bridges this implementation gap. We have started to run a pilot service which integrates the generation of QR codes with existing institutional software.

Two approaches were used when implementing our pilot:

1. to provide software services to support encoding and decoding of QR codes

2. to raise awareness and understanding of QR Codes within the academic community

A web site was provided as the point of reference for individuals keen to apply QR codes to their learning and teaching.

A QR code generator was developed and hosted on the institutional network. This is available through a number of different routes. Firstly, it was available as a stand alone service. Secondly, it is integrated with the University's Moodle installation. To improve the provision for mobile learners an auto-generated QR code was appended to Moodle printouts, providing handheld users with a quick link to that page in the course. The QR Generator is also available as a Moodle Block to provide tutors with flexible and direct access to when creating learning materials.

QR Codes are currently an emerging technology in the UK and while resources exist to support their use, little investigation has been carried out into their application in teaching and learning. Our approach is a significant contribution to understand how we can use QR codes within teaching and learning. The technical developments empowers people to take ownership of their use, in a sustainable and scaleable manner.

This presentation will outline how this has been achieved, discussing the technologies used and our initial findings from pilot.

Keywords
QR Codes

Investigating Personal Inquiry: An Activity Theory Approach

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BACKGROUND

This paper concentrates on how the technological mediation of a GCSE Geography investigation using a location-based inquiry learning toolset, undertaken by students in a UK secondary school can be analysed using an Activity Theory approach. This investigation forms part of the Personal Inquiry (PI) project, one of whose aims is to help 11-14 year olds children to use personal and mobile technologies to make their science learning more accessible and more effective. The GCSE investigation consisted of a number of stages of inquiry into urban heat islands. For further details see Collins et al., 2008.

METHOD

Activity Theory (Engeström, 1999) can be used to analyse and conceptualise the use of personal technologies for inquiry learning. We use this framework to examine the interactions, contradictions and tensions between the multiple, developing activity systems that are constituted when pupils engage in inquiry learning using personal technologies in and out of school. This paper reports on the activity of target children over an extended period of two months. Engeström's extended activity framework is used to represent the main learning and teaching activities for analysing the data: in this one case study, the pupils' use and appropriation of the inquiry learning toolset. We take a multilevel focus on curriculum, group and individual issues to examine specific contradictions, breakthroughs and breakdowns. A previous related school activity on micro-climates which was not mediated by technology provides a helpful comparator from which to explore how the toolset changed the activity. The analysis will draw primarily on pupils' video and interview data together with videotaped observations, and the data, notes and products produced by the learners and teachers.

CONTRIBUTION

Previous work on analysing the technological mediation of problem solving, e.g. (Scanlon et al., 2005) illustrated how contextual factors together with technological affordances could shape activities. The original contribution here is the application of the Activity System Tool Appropriation Model (Waycott et al., 2005), to categorise and interpret data relating to tool mediation and appropriation, and to reveal contradictions in the activity systems of interest.

EVALUATION AND REFLECTION

Our preliminary analytic work on the observational data has identified some critical incidents. Whilst the technology supported the activity effectively through allowing data recording and organisation in situ and representation and easy access to comparative data, it also introduced a level of complexity and itself required practice and support for effective use.

Cross-cultural Adjustment with the Support of Mobile Group Blogging for Student Sojourners

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ABSTRACT
The desire of universities to tap international markets, together with the growing numbers of international students on campuses in many countries raises questions of cultural understanding. In this paper we problematise the experience of newly-arrived international students in the United Kingdom, and consider how the emerging practice of mobile blogging can be a means of informal learning about culture.

INTRODUCTION
The newly-arrived international students' intentions could be thwarted through lack of cultural understanding and adaptation (or 'culture shock'), issues which have been addressed theoretically in various ways (Zhou, Jindal-Snape et al. 2008). Ward, Bochner and Furnham's (2001) theory, influenced by social psychology, involves affective, behavioural and cognitive aspects and considers acculturation as a process that occurs over time, that requires active involvement of the newcomer, and that considers both the person and their contexts. The participants here were a group of Chinese newly-arrived students, who had a similar cultural background and need to learn British culture and who would like to use the new technology. Blogging provides an easy way to publish personal information generated by individuals in forms of text, images, audios or videos, while a moblog enables bloggers to post self-generated contents from mobile or portable devices to a website. As Resnick (1991)claimed, authentic learning is supported in everyday situations by shared cognition through group problem-solving, reliance on external tools and resources and a greater emphasis on manipulating objects than abstractions. For a group blog, collection through mobile devices enables more generic and authentic learning contents to be generated which embed digital interactions among the participants.

METHODS
A host running on PHP was established and Wordpress (a blog server system) was installed. Mobile features were added to the group blog later to enable blogging from mobile devices, so that with any Internet-accessible mobile phone, pictures could be submitted together with texts directly. 12 Chinese participants kept mobile phones with them and blogging for 4 weeks. Interviews and focus group were conducted after that.

FINDINGS
In the period of the moblogging study, a total of 232 posts and 184 comments were posted. Most participants would like to carry on mobile blogging if the technology improved and expense lowered. They would like to keep moblogging for these reasons (listed in order of preference): The majority of participants 'think by posting', and filtered the information they collected before the submission for sharing experiences. People expect positive feedback from blog readers. They believe it's easy to keep inspiration and passion through mobile blogging. Bloggers as learners in this group showed explicit consideration of their audience. The communication built up in this way encourages people to know more about others. Due to the limitation of technology and funding, there are still a lot of issues requiring for improvement to our moblogging system from the technical view. We attempted to have more overseas students involved in the moblogging and look forward to give assistances to more student sojourners, reducing their culture shock and enhancing their adaption.

The Power of Me: Learning By Making Your Own Rich Media Mobile Resources

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ABSTRACT
Mobile learning projects across a wide range of contexts are finding that the best way to keep learners engaged is to include them in the creation of resources, as well as just using them. We will showcase some current tools and examples, as well as highlight key lessons learned.

Author Keywords
m-learning, authoring, personalisation, constructivism, learners as creators, empowerment, evidence, Windows Mobile, MoLeNET, MyLearning Author, Tribal CTAD

Background

Tribal CTAD's mobile learning teams have been working with learners to create and trial innovative approaches to mobile learning since 2001. Our findings line up with many of the current thinkers in this area who have highlighted the importance of collaborative learning. This led us to a more constructivist approach when developing both tools and materials, in which collaboration and active participation are key.

Our tools and technologies have been included in many different projects across the UK. Most recently, the 32 MoLeNET projects (over 100 colleges) were given access to the Tribal m-learning tools sets and encouraged to create their own mobile-enabled learning content.

Methods

It is observation of these and other recent projects that will inform this session, where we will demonstrate and share some of the authoring tools used as well as the emerging best (and worst) practise from the trials.

Contribution

Studies of mobile learning in action show quite distinct, separate levels of learner engagement. These different levels are partially connected to the technologies, and partially to the wider learning model. They can be described as:

3. Shallow or supplementary learning: Typically, these may be SMS prompts, School-generated podcasts, and mobile games. They are good as a supplement to other activities.
4. Focussed learning: Typically these resemble a mobile-friendly version of classic "e-learning", with targetted nuggets of learning that can be engaged with while on the move - possibly context aware.
5. Deep learning: Deep learners are immersed in a mix of mobile technologies, as creators or originators as well as the more common consumers of mobile media, following a constructivist model.

There is a lack of current research into the second point. Many reports favour either the shallow learning (because of the lower entry-cost, using learners' own devices) or the deep learning (often using the most cutting edge of technologies, and the boldest of teachers)

This paper presents a collection of success stories, tools and techniques looking at focussed learning (the second point). We hope to show that by offering practitioners an easy-entry into mobile content creation with these sorts of tools we can encourage more and more practitioners to experiment, and discover the benefits of including mobile learning in their teaching.

Evaluation

Our presentation will be interactive – with tools to demonstrate on-screen, handheld devices to try out, and practitioners to discuss and reflect on both the successes and failings of these approaches.

Up Close and Personal: Evidence of Positives, Tensions and Challenges in the Introduction of Mobile Devices in Learning

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ABSTRACT

This short paper draws on data from Mobile 1:1, a two-year Development and Research project, within BECTA's **Harnessing Technology** initiative. The final report of the project will be available early in 2009.

The research is located within two initiatives (one sponsored by a Local Authority and the other by a City Learning Centre) where pupils and teachers in selected year groups have personal ownership of a mobile device. Three primary schools and two secondary schools have been involved, and cohorts of students have been followed from Year 5 and Year 10 to external assessment points in 2008.

Our findings to date add to evidence that suggests mobile devices can make a positive contribution to teaching and learning. However the process of realising the full potential of such devices is not straightforward. Our research has identified a number of issues, tensions and challenges associated with the development and promotion of 'mobile learning'. In our presentation we will share some of the evidence which illustrates both the positive outcomes and the tensions and challenges, and invite comment and discussion from delegates. A short paper has to be selective and our chosen focus is on the experience of the teachers and, in particular, of the learners in primary schools involved in the project.

Data have been collected using a variety of methods. For this paper we draw specifically on interviews with teachers and learners, surveys of learners' use of and attitudes to their devices, video recording of teaching and learning episodes, and (more unusually) video recording of screens, captured as learners used their mobile devices and talked about what was on them. We have been concerned to look closely at the detail of the learning process.

First , we consider how teachers have developed their teaching in response to the possibilities offered by mobile devices. There are many steps along the road to full exploitation of a mobile tool for learning and our teachers are at different stages of the journey. In general, they have accepted more easily aspects of device use which enable them to retain control in class. There is much that is positive about this stage. Many teachers, however, perceive tensions between device-facilitated autonomous learning processes and those seen as reliable in achieving desired learning outcomes. Developing formative digital assessment is a key challenge.

In relation to learners we focus on the patterns of device use, in and out of school, that the research has uncovered in primary schools. We consider what frequent users are learning and the implications of low levels of device use. Where use of mobile devices suggests a blurring of boundaries between home and school, formal and informal learning, how should we respond? Do patterns of use (high to low) raise questions around inclusion and identity?

The experiences of teachers and learners, of course, are intertwined. They become salient (in the UK) in considering, together, concepts of 'personalisation' of learning, the development of independent lifelong learners, the continued demand for raised attainment and for schools to be accountable. Introducing mobile devices into learning is a brave and risky business. How can we ensure that the full benefits of mobility are achieved to the benefit of all learners?

Seeing the Wood For the Trees: The Challenges of Mobile Device Logging

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ABSTRACT

Personal Digital Assistants (PDA) were used in a series of mobile learning projects conducted at the University of Glasgow in the Department of Electronics and Electrical Engineering and the Robert Clark Centre for Technological Education.

Automated logging was the chosen means of collecting data about how the devices were used. Problems in data collection encountered during the project highlighted difficulties in the quantitative measurement of effects in mobile learning. Even after successfully overcoming a number of practical difficulties, there were still subtle interactions between the measurement process and the group dynamics of the student cohort under study which were disruptive to the collection of mobile learning data.

One area of interest for the project was to determine which applications students found to be “useful” and this provided an interesting challenge. It is implicit to the nature of personal mobile devices that different applications will be considered to be the most useful to different people. The challenge is how to identify the most useful applications from usage patterns recorded in logs.

There are some obvious patterns of use that can indicate an application is useful: e.g. it is used frequently or used for a large amount of time. There are other patterns of use that may also characterise useful application that are more difficult to detect. For example an application that is only used once per day or less, such as to-do list of goals or objectives, could be key to someone’s life, but the importance to the user may not be obvious from a usage log. Also, such events can easily be confused with spurious events, such as launching the wrong application.

This presentation will provide an overview and illustrations of some of the visual representations of log data that have been of assistance in the analysis of comparative device usage, highlight possible learning events and the identification of 'useful' applications.

An alternative analysis method that has also been developed is converting the data to an audible form to provide a different and complementary method for pattern recognition. In its simplest implementation, each application is assigned to a musical note and its duration based on the length of the event. An interesting feature of this method is that it enables analysis of data by users with impaired sight thus adding accessibility to the data which might have much wider application than the study reported here.

Major research themes which have developed from this work include the impact of data collection itself of the student experience, the potentially disruptive impact on trial participants of the introduction of novel technologies and the challenges of analysing and interpreting mobile usage logs.

Author Keywords
PDA mobile logging evaluation

Future Mobile Learning Environment - to the Future via Scenario Analysis and System Modelling

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ABSTRACT

The Finnish Mobile Learning Research Network expects to meet future challenges through its *Future Learning Environment Scenario Program* which focuses on helping to provide students with essential 21st century skills. The program aims to develop learning and teaching, educational technology, and learning environments in a point of view of mobility, m-learning and wireless solutions.

In our long-term effort to define and develop a mobile learning environment that supports Future Schooling, scenarios mapping out the future learning and *MOOP-learning environment* were analyzed. Scenarios written by elearning experts were analyzed in order to define pedagogical needs for future mlearning environments that transform the role and restrictions of a physical learning environment. In this presentation, we present the system model of the future mobile learning environment and discuss the possibilities of the method we have developed to integrate various learning environments as a coherent and holistic wholeness.

Key variables and week signals were sought out of the scenarios in order to define the variables and the relations between the variables. These were classified to *soft variables* and to *hard variables*. Soft-variables included factors like interaction and interaction models, sense of learning community, situations supporting learning, learners' cognitive processes, a structure of the learning process, authentic context, methods and learning needs. Hard variables included learning resources like materials, actors in a learning environment, tools and devices and applications and a system in a learning environment. Variables and the relations between them were use to build up a system model of the future mobile learning environment.

When comparing a system model of the MOOP-learning environment and the system model of the future mobile learning environment on the overlapping levels, the development needs are easy to identify. This ensures us to have a solid base as well as a clear vision and strategy for the development work of the mobile learning environment and insight to more beyond the mobile learning. In addition, this provides very useful method and a tool for comparing learning environments to each other. The method makes possible to meaningfully integrate various learning environments (like physical learning environment and virtual learning environment) by creating a new system model for the integrated learning environment by the union of the system models of the individual learning environments.

One major challenge ahead is to build up mobile learning environment that enables simulation learning in the authentic context.

Leading the Development of an m-Learning Program Using Pocket PC's at Highvale Secondary College, a Principal's Reflection.

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ABSTRACT

This paper focuses on the leadership perspective in developing and implementing a mobile learning solution at Highvale Secondary College a State Government school in Melbourne, Australia.

Highvale is a well established, coeducational school of 750 students aged 13 to 18. I was appointed as principal to the school in 2006. It offers a vertical curriculum structure consisting of many individual elective studies. These have been taught by the same teacher for a number of years. Consequently there has been limited teacher collaboration and team work; an improvement area highlighted by recent three year school review. The pocket pc program has been designed to be the catalyst to change this and support pedagogical reform.

A professional learning team focusing on the application and adaptation of pocket pc to education was formed in 2007. All learning areas were represented and each member of the team (22) was equipped with a pocket pc that the school provided. Research from BECTA (UK) and the Palm Pilot Schools (US) was used as the initial staff professional reading program. A technical support officer was appointed and a teacher professional development program was developed. This included regular support group meetings, presentations of applications and teaching and learning strategies and a buddy system set up to support teachers. A class set of pocket pcs was provided for teachers to use in their classes. Over 2007 teachers developed and evaluated pocket pc lessons. A weekend residential conference was held in September where each teacher shared their work. The school is now in its second stage with the establishment of three pocket pc classes of Year 7s (13 year old students). Parents opted into the program by contributing some $400 (£ 180). Our students take their device to all lessons and are instructed by their class teachers in the applications for that lesson. A regular mlearning newsletter is provided by the school to inform parents and students of developments, issues and technical points. This has been very well received.

We have gained the support of senior researchers from Latrobe University, Melbourne to assist us in undertaking action research to evaluate this program. Methods used include survey tools for teachers and students that captured attitudes, expectations, and capabilities, reflective journals and focus groups. Preliminary results will be made available at the 2008 mlearn conference.

So far this program has delivered success in formation of team approach to curriculum development, collaboration across learning areas. It has enhanced the role and involvement of parents from school council and the community, particularly in software development. Limitations that I see continue to be the attitudes of long serving staff to embrace change. We believe that the program has demonstrated significant potential in the provision of affordable, accessible, multimedia tools to engage students in learning.

It is our intention to extend this program across the school in later years and will be a distinguishing feature of Highvale Secondary College.

Beyond Project Status – Implementing Mobile Learning on a Broad Front.

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Background

The paper presents an overview of the state of play of the Wolverhampton Local Authority's 'Learning2Go' initiative. This has been developing the use of handheld computers on a full-time 'ownership' model by learners across the school and further education age range. Three other presentations are offered to the conference which fit into the context of this overview: Engaging Young Learners with Mobile Technology and Strategies for Enabling Mobile Learning in the Secondary Phase
'Utilising Mobile Learning to Engage Hard to Reach Children & Young People'.

Contribution

The initiative has been coordinated by a small central team in the Authority with schools and colleges buying-in voluntarily based on their perception of its potential. The initiative's leader is Dave Whyley, Headteacher Consultant to the Authority, who describes their strategic vision for handheld devices, setting out the context for the work presented in the related papers and the emerging long-term strategy. The role of a project leader is examined in the context of the potential tensions between strategic leadership at Authority level and the increasing autonomy of schools and colleges.

As an on-going evaluator and critical friend to the Learning2Go scheme over four years, David Perry was engaged in summer 2007 to examine developments in a range of locations representing the use of handheld devices across a wide age range from Key Stage One to adult.

From summer 2008 he has been evaluating the Learning and Skills Network funded 'MoLeNET' project in the City, known as 'Learning2Go Further'. This extends the use of handheld devices by equipping learners working in locations remote from their 'home' institution*:* Wolverhampton City College learners in workplaces long-term; and school learners in workplaces on short-term work experience.

Also, in summer 2008 David Perry reviewed some trials exploring the value of contrasting makes and types of handheld or small computers in schools with varying ages of learner.

Evaluation

David Perry's work makes a critical appraisal of different types of handhelds in different learning locations subject to varying pedagogical styles and learner needs and seeks to report on the implications of these variations. Handheld computers are found to have quite distinct advantages but also to make demands on both learners and their supporters (teachers; tutors; employers; the LA) which have not always been responded to adequately. Issues of change management arise therefore.

Reflection

Good value has been identified in all the learning locations studied and also limitations to the devices and their users which currently limit progress. All these aspects are described. Dave Whyley relates the value gained to the Authority's strategic vision and similarly, shows how he expects changes in technology, connectivity, school management and pedagogy to enable the fulfilment of that vision.

Ethical considerations in implementing mobile learning in the workplace

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ABSTRACT

Workplace based personal and professional development is essential for students in the health, social care and teaching professions. In this era of ubiquitous computing recording, reflecting on and reviewing of such student development is easily provided for through mobile, electronic tools. Yet student users in work-based settings, such as those targeted by this paper, continue to find using personal, mobile technologies a challenge; though now it is much less a technical challenge than one requiring institutional and cultural innovation in permissions and behaviours within these settings.

In addition, we should note that the nature of research into the use of mobile learning in the workplace involves investigating the use of personal, private devices by people of a range of ages and abilities. This will immediately raise questions in lecturers' and teachers' minds, as well as in a researcher's, over how best to approach a potential minefield of ethical issues. These range from privacy, through informed consent (especially over the use of images) and confidentiality to safety. Nowhere is this more obvious than when training young teachers, nurses, social workers or midwives in their chosen professions. Questions that have been already asked of the presenter and by researchers as well as trainees include:

- What if I see inappropriate images on a students' mobile phone?
- How do I set up a study on handhelds in a college where the use of mobile devices is banned?
- Can I take photos of a patient's cuts and bruises on my PDA for my wound care project?
- A trainee has sent in video of his pupils as evidence of teaching through role play – can I show it to others?
- Am I sure that the use of mobile phones with young people is actually safe?

This paper builds on work by the presenter on using handheld devices to support students on placement in the workplace. It will share the results of a recent international workshop conducted with experts in the fields of mobile learning and education at all levels (including junior schools, high schools, colleges and universities) on prioritising areas of concern and establishing best practice. The presenter will invite active participation from the delegates in further reflection on ethical considerations that must be addressed to ensure the sensitive and successful integration of mobile learning into education for professions in health care and education.

Author Keywords
Ethics, ethical issues, privacy, consent

ACKNOWLEDGMENTS

The author wishes to acknowledge the contributions made by participants and presenters at the IAS Workshop held in Bristol in June 2008. See http://www.bris.ac.uk/education/research/networks/mobile/events/iaswshop7notes for the report.

A Future School Proposal: Mobile Learning through Authentic, Experiential and Collaborative Learning

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ABSTRACT

This paper will present a Future School's Mobile Learning proposal that is guided by the principles of Experiential Learning. As a Future School, the extensive literature review that was undertaken gave rise to proposals schools can consider. As part of the 4-year FS Experience, 3 major key programmes that are identified, Discover, Global and Attuned Learner, will set to transform teaching and learning. One of the proposed IDM/ICT tools harnessed for revolutionalizing the learning experiences and environments is the use of Mobile Learning Technologies.

Mobile Learning proposed in the school will refer to anytime, anywhere access to learning; incorporating both formal and informal learning, inside and outside the school premises via a personal learning device, through experiential learning experiences set in real-world, authentic scenarios in an engaging personalized or collaborative knowledge building experience.
The application of mobile learning activities augmented and based on mobile technologies such as wireless connectivity and mobile devices, prepares pupils to learn anytime and anywhere. It will facilitate the pupils drawing upon each other and in the construction or uncovering of knowledge. Mobile learning also enables a bridging of formal and informal learning experiences and environment, and thus facilitates a seamless integration and transfer of learning experiences across such learning environments.

IDM augmented mobile learning can ensure a seamless integration of 'context sensitive' learning experiences into the formal classroom learning and vice versa. Through such exposures in 'open environments', learning become engaging, authentic and experiential, also an active process in which pupils are required to construct ideas through the reconciliation of their existing knowledge and the new information they gather on the grounds or even via open sources like digital repositories or an internet source. Leaning experiences based on mobile learning activities such as learning trails will integrate social technologies such as Wikis. They will also be structured to facilitate collaborative learning against the milieu of collective construction of knowledge.

Furthermore, with a 1:1 mobile computing, learners can use their personal learning devices to customize their personal learning environment, making connections and organizing the parts and processes in a way that makes the most sense to them. Learners then are able to work at their own level & pace (wherever and whenever), using their time differently depending on their own learning styles and needs, staying organized and on the topic in a way that would be much more difficult without their own personal learning device.

This proposal will be undertaken by a central Future School Project research question: 'Whether the integration of emerging and current technologies can bring engaged learning for pupils and equip pupils with the skill set necessary to be able to operate efficiently in an IDM pervasive and pre-dominated world.', which serves an the guiding beacon for our vision of Education for the Future.

TA Model for Implementation - The Learner Response Technology Pyramid

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Background

This poster represents one of the main findings from the REVEAL Project: a two year large scale, longitudinal, mixed methods research and development study into the effective use of a leading brand of Learner Response System (LRS).

Led by the Midlands Leadership Centre, Education Partnerships, University of Wolverhampton, the project aimed to disseminate best practice in the use of the Activote learner response and voting system, highlighting key uses and creative ways of working in the classroom. As the biggest European study of its type the REVEAL project contributes to the current research field in the area of response or 'Voting' technology. Key outcomes of the project, such as the practitioner support DVD provide a range of solutions and recommendations for developing professional practice. A detailed framework for progression of use and professional development in relation to learner response technology (The Response Technology Pyramid) now provides practitioners with practical guidance on how to introduce and utilise the technology effectively. Key findings are applicable to other brands of multiple choice learner response system. Activote is currently the leading brand in terms of unit sales across Europe.

Methods

Data was collected through a range of methods: questionnaires, teacher, pupil and LEA interviews and lesson observations. Educational institutions in 11 local authorities across the UK were visited 3 times which has resulted in 150 lesson observations being completed across all age phases. Each visit also had a development focus with practitioners and schools being supported in their use and application of the technology by the REVEAL team through individual support, team teaching, demonstration activities and staff meetings. Ten detailed case studies were also written and are available for download from the project website. Each case study includes example lesson activities that are related to the Learner Response Technology Pyramid.

Contribution

The project focused on a range of areas, however, for the purposes of the poster presentation we explore the Response Technology Pyramid and how it can be used to successfully implement and develop the use of this technology in educational establishments across different age ranges. The pyramid outlines and range of preconditions for use of the technology and explores five key levels, these being, Participation and Engagement, Feedback and Response, Interaction, Question Centred and Data Led uses. Each level of the pyramid will be outlined through the poster and is supported by excerpts from the project DVD. In addition, copies of the 'Final Report for Practitioners' document containing detailed descriptors relating to each level of the pyramid will be available for visitors to take away. This presentation provides the only known framework for practitioners to identify their current level of use and to highlight ways forward when using the technology.

Evidence

The poster contains a large, annotated, version of the Response Technology Pyramid. Delegates will receive a copy of this supplemented by a Free 50 minute TV quality DVD programme that explores the key findings of the project and includes classroom footage that explores each level of the model displayed on the poster. The DVD also contains numerous other resources and support materials.

Guerrilla Learning – Developing Highly Enjoyable, Deeply Engaging and Professional Looking Educational Games for the Mobile Phone

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ABSTRACT

Mindset Network is a not-for-profit organisation producing and distributing digital educational material for the public Health and Schooling sectors in South Africa with a particular focus on underserved areas and communities. A recent project has seen Mindset develop a range of mobile content focusing on Grade 10 Mathematics and girl learners. The scope of the project included developing two new and innovative mobile games. The game development was exploratory in nature and served to provide input into the debate around whether "educational games" should first be 'educational' or 'addictive', or whether a middle ground could be found and what this was.

Two games were developed. Mathstermind is based on the concept behind Mastermind but requires players to solve Mathematical puzzles using deductive logic and an understanding of a range of concepts from simple arithmetical operations to inequalities, algebraic equations and graphs. The Mathematics is explicitly presented and it is the carefully scaffolded nature of the game that continues to motivate players to learn and apply the Mathematics involved. Fashion Empire is a simulation styled game requiring learners to build and run a fashion company making and selling a range of garments. In this case Mathematics is no less required but is implicit in the game, players instead being motivated to acquire the necessary skills by virtue of the desire to run a successful company and generate income. A particularly unique and innovative feature of the design process is that both games are explicitly based on the South African schooling curriculum. The games were developed in South Africa by South Africans. Mathstermind is built in FlashLite while Fashion Empire utilises the Java MIDP2 standard. Both environments enjoy wide and growing support on mobile devices but each has specific strengths and limitations.

The games have been developed and a pilot project is underway in two disadvantaged areas in South Africa. The contribution to both the game developing community in South Africa as well as the learners in under-resourced schools is documented. Mindset is exploring the modalities that lead to games that are highly enjoyable and deeply engaging (addictive) but that also readily lead to learning that has meaning and value beyond the context of the game itself. Technically, by working in both development environments, Mindset is developing a set of technical criteria to inform future game design and development processes.

The poster will, by way of flow diagrams, graphically illustrate the game conceptualisation, prototyping, development and testing process to final product. Thus, the full participatory design process will be described and the lessons learned explored. The modalities involved in designing enjoyable, engaging games with a high educational value will be presented as well as a set of technical criteria for developing in the FlashLite or Java environments. Discussion around the game development process will be initiated as to the relevance of the games to a disadvantaged context as well as the process of capacity development of this arena in South Africa.

We’re Playing a Game……..

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Background

Sony’s PlayStation Portable (PSP) is a mobile device that has the potential for a variety of learning scenarios.

It’s a device that allows the learner to listen to audio, view images, watch video as well as surf the internet wirelessly. It has a built-in RSS reader allowing content and learning to be pushed to the learner. With the camera attachment the learner can take photographs, shoot video and video conference.

In the near future we can expect to see GPS capabilities, phone calls via Skype and a (real) keyboard for text entry.

You can even play games on it!

Methods

Gloucestershire College has been using mobile learning to enhance and enrich the learning process for a wide variety of learners across the breadth and depth of the curriculum. They have developed a range of learning scenarios and activities that are integrated into the learning process and support a diverse range of learners.

One of the key devices the college has been using is the PSP. Using a set of PSPs (with cameras), a range of learning scenarios have been created which allow the PSPs to be used to enhance, enrich and support learning.

The work has focused on how the pedagogy needs to drive the scenarios and not the technology.

Contribution

Our mobile learning project has put in place an infrastructure at Gloucestershire College that will allow learners using devices which they already own to access learning activities and content through a mobile learning portal in conjunction with the college VLE. The project will create a student wireless network that can be accessed by learners’ own devices to access college services, e-resources and the internet.

The project will provide mobile devices to learners in selected groups; including excluded learners and learners with learning difficulties and disabilities.

The project will provide hardware and software that will allow both staff and learners to develop, create and convert content for use on mobile devices.

The project will provide the infrastructure to allow the college and staff to communicate with learners’ mobile devices through the use of 802.11 wireless and Bluetooth technologies.

We have purchased a range of devices, however this poster will focus on the work we have done with the PSP.

Evidence

The poster will through a series of short case studies demonstrate how the Sony PSP can be used to support, enhance and enrich learning.

There will also be information on the potential of the PSP itself. Explaining how, through a photograph or diagram of the PSP, the different features of the PSP and how they can be used for different learning activities.

Geolearners : Informal Learning in the Wild

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Background

Mobile technologies are increasingly diverse and powerful, offering high resolution image, video and audio capture, internet connectivity via the mobile phone network and wireless hotspots together with Global Positioning System (GPS) to pinpoint physical location. Alongside these developments in mobile technology, we have seen equally far-reaching developments in the collaborative opportunities offered through fixed computer technologies. The term Web 2.0 refers to internet-based technologies that have evolved, largely independently of each other, and which facilitate creativity, knowledge sharing and collaboration.

This poster illustrates a study investigating the impact of these technologies on informal learning. The study examined the online community of Geocachers, looking at how they were using mobile and web 2.0 technologies and mapping the findings onto the five attributes of socially constructive learning (Jonassen et al., 2003). Geocaching is a form of GPS-guided treasure hunt where members hide and seek caches in the physical landscape. Geocachers may be based anywhere in the world. The community focus and initial point of contact is via the geocaching website which contains descriptions and locations for all hidden geocaches, as well as member details together with other information relevant to the community.

Methods

The study targeted geocaching enthusiasts, recruiting participants for a web-survey using an invite posted on the geocaching web forums. The web-survey contained both quantitative (check box or radio button) and qualitative (free text) questions and generated 659 responses. These were analysed using Nvivo and a set of 5 linked case studies were then interviewed by telephone or email. In addition, selected content from the geocaching website and web forums was analysed.

Contribution

The research initially focused on informal learning that occurred in the wild (Hutchins, 1995) as a result of geocaching; looking up information to create caches, learning about locations by reading that information, learning to use different types of GPS technology to locate the cache. However it became apparent that the learning opportunities extended beyond the basic activity of geocaching. For example, the concept of cache location was given a temporal aspect to create a cache that could only be logged at a particular time of day and geocachers were using technologies such as blogs, FlickR and YouTube to share hints and tips about geocaching.

Evidence

A geocacher may act as a more knowledgeable peer when designing, creating and describing a geocache, and as a learner when using the GPS and clues to find a cache. Geocachers use a variety of mobile and Web 2.0 technologies to support their activities, and many of these activities give rise to informal learning opportunities. This poster illustrates these multiple yet complementary roles using graphics to represent geocaching artefacts, showing how they create a learning web connecting people, artefacts and places.

Ubiquitous: interactive SMS and then…

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Background

Ubiquitous is a mLearning project based on cell-phone activities. The mechanism on which it is built is that of 2-Way SMS, typical system used for commercial contests. The project's basic idea is the application of such system in educational contexts. That is why the project team has developed a deeper interactivity between mobile device and user. In fact each participant communicates with the server through specific instructions in order to receive determined learning activities. The command START allows to begin a new distance learning activity, such as a multiple choice quiz. The user replies with an SMS (example: ANSWER "yellow").
The system interprets the answer and sends an immediate feedback, consequently, depending on the type of activity, either progresses with the activity or awaits for further commands.

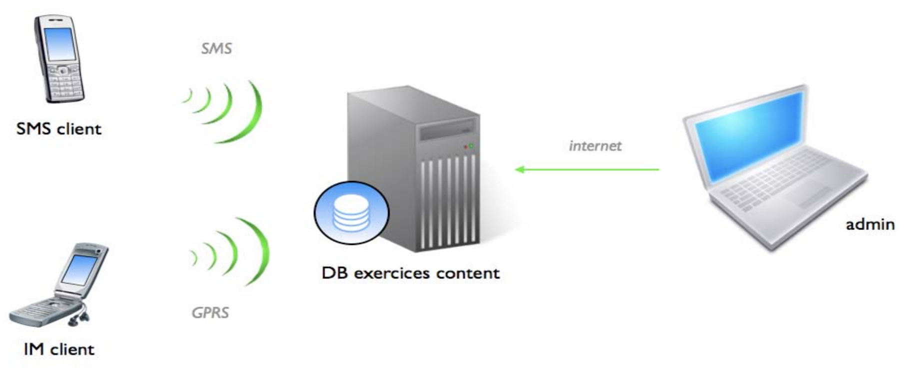
Methods

The list of commands recognized by the server ("dictionary") becomes part of the language used by the participant. The interactivity between user and system becomes a communication based on a common dictionary, growing once new activities are carried through. The server in such situation behaves like a bot (robot), either waiting for a contact on the part of the user or communicating on the basis of regular time intervals.
The previously cited dictionary, can eventually turn out to be a flaw of the system. In fact, for the user becomes more and more difficult remembering all the available commands, even those active during a specific activity. It becomes then necessary to create an intelligent system able to guide the user into a correct formulation of the instructions, causing time expense and costs to increase.

Contribution

An eventual system evolution might offer parallel Instant Messaging (IM) activities. Through this information access methodology it's possible to duplicate the information access way, in order allow the user to interact with the system however he/she prefers, to facilitate the activities' use, for system integration or for cost containment.
The application of IM activities opens new perspectives to the project. Cell phones currently on sale already integrate an IM system. In this case it becomes possible to configure the system by sending configuration SMS.

After the configuration, the user has the possibility to question the bot, carrying through all the available activities in short times and low costs.



The data communication of an IM system runs on a GPRS or superior network, and not anymore through single SMS. Moreover the system allows a more complete interaction with the bot, enabling the request of more specific aids related to each learning activity.

Evidence

With the possibility to implement an IM system, comes the possibility to have a common data bank with which it will be possible to interact through SMS or IM (chat). Furthermore, an administrative interface is available, allowing trainers to follow the various mLearning activities.

mi-Guide @school – A Mobile Learning Application in a Museum Context

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The Museum of Science and Industry in Manchester recently launched a gallery devoted to the story of telecommunications. Forming part of BT's Connected-Earth national museum, this gallery is unique in adopting the mi-Guide multimedia hand-held visitor information system designed at the University of Salford. mi-Guide offers visitors an enhanced gallery experience by providing context-specific information on selected exhibits through audio commentaries, images and supplementary video clips. It is now being extended to offer a new @school service. Here teachers will be able to access National Curriculum relevant content for use within the classroom but more importantly, when visiting the gallery, students will receive a tailored learning activity delivered through the mi-Guide hand-held device. The @school service therefore provides an integrated education application combining classroom based learning delivered via a VLE with situated learning in a museum gallery facilitated using mobile technology.

The new mi-Guide @school service requires us to enhance our system architecture to enable learning activities to be made available to teachers through a web interface and also to deliver a tailored experience within the gallery. Within the gallery, the @school service will present a set of learning activities which students can follow. In this way, the system needs to track and guide students to specific locations and exhibits within the gallery and then to deliver newly authored materials which in themselves must reflect the prior learning done in the classroom and the age-group of the students. Development of this new content is being carried out in partnership with the Centre for Science Education, the Salford City Learning Centre and selected partner schools.

The first phase of mi-Guide used a mobile multimedia application to engage museum visitors and manage their cognitive load by adopting the proven look and listen rather than look and read paradigm. When a mi-Guide enabled hand-held device is placed next to an exhibit, relevant content is retrieved and played. Currently, users choose when to consult the guide for information; however, context-aware mobile applications such as mi-Guide have great potential for engaging learners through interaction in authentic environments, and this is the aim of the @school service. The contribution being made by the mi-Guide @school service is to provide an integrated learning environment that exploits a mobile learning application to supplement and enhance conventional methods. A key deliverable of our work will therefore be to assess the effectiveness of such an approach.

Our poster will show how the existing museum tour can be extended for use within the classroom. The poster will include photographs to show the use of mi-Guide in context in the Museum and a diagram will provide a high-level overview of the forthcoming @school service using graphical representations of the system to make it visually appealing and accessible to a non-technical audience while clearly illustrating how the key components of the system work together to support learning within the school and in a museum.

Enhancing Moodle for the Mobile Learner

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ABSTRACT

Many UK educational institutions are developing their Moodle installations to enhance the experiences of their mobile learners. One approach has focussed on either enhancing the stylesheets or changing the underlying code of the Moodle application. An alternative approach has focussed on developing new software or a web services layer that enables the functionality and activities in Moodle to be accessed in a more usable manner on a mobile device. In many cases this has involved creating a client which needs to be installed on the device. At the University of Bath we have taken the decision to roll out our enhancements through developing a set of stylesheets that are optimised for the mobile browser. This decision was influenced by the need to provide the improvements in a sustainable manner given our resource and priorities.

The advantages of using Moodle include it being open source and based on a popular programming language. Therefore, it is relatively easy for institutions, with the appropriate staff skill set, to make enhancements for learners using mobile devices. However, a disadvantage of using a low threshold technology is many of these exciting developments are not being disseminated to, or built upon by the wider community.

The aim of this poster is to address these two issues. Firstly it will disseminate how and why the University of Bath have decided to develop a set of stylesheets optimised for mobile browsers. In particular, what do the new stylesheets look like? What design decisions where made and why? How have they been received by users? Secondly, it will encourage other delegates to leave short messages, including their contact details (name, email or web links) to disseminate how they have been enhancing Moodle for the mobile learner. This will act as a physical notice board. After the conference these messages will be collected and uploaded for archive and continued discussion on http://www.mobile-learning.blog-city.com.

Keywords
Moodle Mobile Learners

Evaluation of a Modern Mobile Development Platform: the Open Screen Project

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ABSTRACT
Education providers face a challenge in choosing a development platform that will deliver a complete rich Internet experience on mobile, desktop and other devices. Various web and mobile development platforms exist but does a single development platform exist to bridge the divide between mobile, desktop and other devices? The Open Screen Project proposes to be such a platform dedicated to driving rich Internet experiences across televisions, personal computers, mobile devices, and consumer electronics.

Author Keywords
Mobile Development, Flash Lite, AIR, Mobile Software, Standards, Convergence.

BACKGROUND

On 1 May 2008 Adobe and various industry leaders announced the Open Screen Project (OSP). Partners include the top five mobile phone vendors (ABI Research, 2008): Nokia (40.3%), Samsung (15.2%), Motorola (9.3%), LG Electronics (9.2%) and Sony Ericsson (8.3%). OSP is "dedicated to driving rich Internet experiences across televisions, personal computers, mobile devices, and consumer electronics" (Adobe, 2008). OSP proposes "to enable a consistent runtime environment – taking advantage of Adobe Flash Player and, in the future, Adobe AIR - that will remove barriers for developers and designers" (Adobe, 2008).

The OSP proposes to remove restrictions on use of the SWF (flash) and FLV/F4V (flash video) specifications; remove license fees for embedding on devices; release device porting layer APIs – allowing a consistent runtime that can be updated over the air across all different devices and publish the Flash Cast protocol (Adobe, 2008). What benefit or challenges will OSP bring to new and existing web and mobile developers; will it end market fragmentation or merely drive competition?

METHODS

This paper evaluates The Open Screen Project through:

- Identifying and comparing the strengths and weaknesses of the underlying technologies: Adobe (AIR, Flash Light) iPhone SDK, Microsoft Silverlight, Microbrowser (XHTML, WebKit) and JavaFX (mobile / J2ME) ;
- Estimating current market share of mobile platforms in terms of technology as well as the devices in use;
- Determining platform availability, functionality (learning curve, debugging, emulators, etc.) , price and support;
- Investigating development communities currently available and Software Development Kits (SDK's).
- Identifying frameworks as well as methods for proper testing and quality control (B'Far & Fielding, 2005).

CONTRIBUTION

This paper aims to determine whether an all-in-one solution currently exists that will enable educational providers to deliver the same complete rich Internet experience to (as many as possible) students across both desktops and devices. By comparing development platforms it should be possible to determine if the Open Screen Project will allow developers and designers to publish content and applications across desktops and consumer devices, including phones, mobile internet devices (MIDs), and set top boxes, or whether another platform should be chosen.

Visualising and Hearing Log Data

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ABSTRACT

Personal Digital Assistants (PDAs) were used in a series of mobile learning projects conducted at the University of Glasgow in the Departments of Electronics and Electrical Engineering and the Robert Clark Centre for Technological Education.

An automated logging system was used to record how the PDAs were used. The intention had been to convert the logs into a suitable format for importing into statistical applications, however performing analysis by this method was found to be slow. We found that to investigate subtle patterns of use required a more immediate and interactive means of exploring, visualizing and filtering the data. To achieve this an application was written to visualise the log data and also to provide audio representations of activity so that patterns could also be *listened* for thus providing an additional and complementary method for pattern recognition.

The poster will show examples of the diagram and chart types that were found useful to represent multivariable data from multiple users and explanations of how audio representations can help to identify patterns in the data.

Author Keywords
Mobile logging evaluation

Mobile Multimedia Language Learning Activities

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This poster will present prototype activities for mobile multimedia language learning. The activities are designed to support taught language modules in Higher Education. The modules are offered through a blended study mode: students attend a 3-hour class every week and complete 3 hours of self-study online through a package called the London Met e-packs (http://www.londonmet.ac.uk/e-packs). The e-packs have been designed in Adobe Flash and offer visually attractive, interactive exercises, which allow for the combination of sound, images, graphics, videos and text within a single activity. Each language package contains 11 topic-based units that are divided into 10 exercises, allowing learners to practice the language learning skills of listening, reading and writing. There are also exercises giving grammar practice and cultural tips. Learners are involved in a variety of activities such as matching, gap-filling, reordering and multiple choice questions through games and task-based activities. One aim of the e-packs is to engage learners actively in the language learning process through motivating and fun exercises.

Prensky (2007) states that whilst most teaching happens in a linear way through presentation and telling and in a format that fits all, 21st Century's learners (digital natives) learn from being engaged, by doing, through game play and exploration, whilst multitasking online. In this context, the London Met e-packs are an attempt to engage, motivate and break traditional barriers for these learners. In previous studies on the use of e-packs learners have highlighted the flexibility of the package as a main contributor to their language learning in autonomous mode. They cited being able to plan their learning in terms of place, time and amount of content, and they were also able to develop personalised learning strategies through choice of exercises and through accessing the scaffolding or support features.

A recent initiative has been to develop some prototype language activities for the mobile phone. Students all possess a mobile phone now, and the short bite-sized exercises developed for the e-packs are ideal for mobile learning, where short activities can be used whenever there is a need or an opportunity to engage in some learning.

Five activities have been developed for the Nokia N95 phone as a proof of concept. They demonstrate a range of different styles of activities: three are adapted from the e-packs, and two are new types of activity developed to take advantage of the opportunities provided by the mobile phone. These include a vocabulary activity, a grammar quiz, a video true/false activity, a grammar presentation activity and a vocabulary search activity.

In the poster session, we will have some Nokia N95 phones for people to try out the activities, and we will be able to discuss some of the issues involved in the development process. The prototypes have also been evaluated by a group of students, and some of their feedback relating to mobile language learning and the activities developed will be presented.

Reconfiguring Science Learning Contexts Using Mobiles

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ABSTRACT
Educational e-Science is about new ways of teaching, learning and participating in science and the technologies that enable these. Teachers can design activities that engage learners in conversations with other learners and scientists around shared experiments, tools, data, results and analysis. Our interest is in designing the technology for teachers to easily and efficiently deliver such experiences. We describe e-Science in terms of those interactions and activities, which we wish to motivate. This provides us with evaluation criteria both for the learning design and for any technologies employed: do they promote and support the desired interactions? Good design also requires a deep understanding of context, not only the physical environment but also the available resources (human and other), interactions between these (e.g. awareness of each other) and constraints (e.g. organisational norms, curriculum, rules). We describe work towards understanding school science learning contexts and specific roles for mobile technologies in reconfiguring these.

Author Keywords
Science Learning, e-Science, Context and Design

METHODS
Through an exemplar e-science activity we have been exploring the affordances of mobile technology and developing our understanding of how to reconfigure school learning contexts using technology so as to best support this activity. Our 'DIY Energy' activity, run at science festivals and in teacher workshops, challenged learners to build and test a wind turbine. They captured evidence of their design and experiment using mobile phones to upload photos and video. These data are linked to experimental reports posted to a blog (http://windenergyexpt1.blogspot.com). Results are shared through a Google Docs spreadsheet. Participants are encouraged to view and comment on others' designs, reports and data and to converse about these, wind energy and related issues with an expert through Skype. Analysis of observations, video data and participants' comments help identify appropriate roles for technology and reveal contextual constraints.

CONTRIBUTION
Mobile phones were successfully and enthusiastically used for data capture and upload. Skype on a laptop projected to a large display very successfully supported conversation with our expert. However, Skype is blocked on many school networks. One way to circumvent this is to use a mobile phone or 3G modem for access. Typing experimental reports on a laptop and posting was less engaging than the experimental activity itself. An alternative might be to produce and post multimedia reports. Mobile phones clearly can support data capture and upload and may also have a role in enabling teachers to temporarily overcome some constraints typical in school contexts (e.g. blocked applications and websites) and enable interaction with outside resources such as science experts. Enabling easy browsing of shared data repositories, scaffolded composition of multimedia experimental reports and posting to the web directly from phones may better engage learners in reflection. Our on going participatory design and research with teachers aims to explore how they might use their own mobile phones to successfully author and deliver educational e-Science activities that work in school and other contexts. Evidently, there are still many contextual constraints to overcome such as the total ban on children's mobile phones in many UK schools. Our poster presents diagrammatically the interactions we wish to support in educational e-science and examples of how technology can support these. We encourage viewers to annotate it with their examples of how mobile technology can facilitate such interactions in specific learning contexts.

ACKNOWLEDGMENTS
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BLOOM (Bite-sized Learning Opportunities on Mobile Devices)

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Background
BLOOM is a new project funded by the eTEN office which is designed to bridge the digital divide within the EU passenger transport and logistics sector.

The project aims to take a mature mobile learning technology - delivering key skills and lifelong learning – and market validate it across several countries in Europe within the passenger transport and logistics sector

For a full description visit the project website at: http://www.bloom-eten.org/

Methods
The project supports lifelong learning, encouraging excluded groups to upskill and enhance their employment prospects through a programme of blended technologies, in which mobile learning plays a critical role.

Contribution
BLOOM is demonstrating that workplace learning via mobile devices is a viable option that can add value to learning.
It delivers basic skills as part of lifelong learning within the passenger transport and logistics sector by contextualising the learning areas to meet the requirements of the sector and the workplace.

Evidence
The poster will include images of BLOOM PDA quizzes and visuals from the mediaBoard developed for use with m-learning. Demonstrators will be on hand to showcase some of the resources.

UNITE

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Background

UNITE (Unified e-learning environment for the school) is a 3 year EU funded project which involved 13 partners in 10 countries, the completion date is July 2008.

The overall goal of UNITE is to contribute to the improvement of Europe-wide education in secondary schools based on common, innovative principles in technology, in pedagogy, and in learning scenarios, all tested against a well-defined validation framework.

Tribal's role, specifically, has been to integrate mobile learning into several existing, web-based learning systems to offer a more complete

mobile- and non-mobile learning experience.

For a full description visit www.unite-ist.org

Methods

Learning scenarios were developed using existing m-learning tools: MediaBoard, Mylearning Author for Windows Mobile and SMS quiz author. These tools were adapted by European partners to fit in with their curriculum requirements and cultures of learning. These individual scenarios were then shared between partners and tested against different cultural and pedagogical backgrounds.

Contribution

We wanted to find out how m-learning can be used to enrich learning in different countries and for different curriculum requirements, then to share and exchange these experiences with the other partner countries.
M-learning tools were not only used within one country's school, but also to enable communication and collaboration between partner schools. Students shared information via mediaBoard and created PPC games for their partner schools in other countries.

Evidence

The poster will include visuals from mediaBoards that were used in the project as well as quizzes developed for PDAs. Demonstrators will be on hand to showcase some of the resources and discuss project activites, and findings.

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