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Conference Proceedings

Long and Short Papers

6th Annual International
Conference on Mobile Learning

16–19 October 2007
Melbourne Australia

Melbourne Exhibition and
Convention Centre

16 – 19 October 2007, Melbourne Exhibition Centre, Melbourne

Conference Proceedings

Long and Short Papers

Long & Short papers were subjected to a double-blind review process by an international panel and evaluated on the basis of their significance, originality, and clarity of writing.

Mobile learning research and development is a challenging field involving collaboration across the globe; contributions shared formally and informally with colleagues enrich our conversations and combined understanding in this evolving field.

Melbourne, the host city for mLearn 2007, provided a rich variety of sessions; from the Doctoral Consortium held at The University of Melbourne to the illuminating sessions held at the Melbourne Exhibition and Conference Centre.

The international conference series provides fertile space for an exchange of ideas and challenges surrounding teaching and learning with mobile devices.

This publication contains the papers from the mLearn 2007 conference 16 – 19 October 2007; we hope you will find the papers presented here valuable for reflection and future initiatives.

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Victoria University

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The University of Melbourne

Please note that papers contained within appear exactly as submitted for the mLearn 2007 Conference, and have not been subject to editing.

About mLearn

mLearn 2002 was the first European workshop on mobile and contextual learning, held at the University of Birmingham. mLearn 2003 was the first Conference, held in London. Both were supported by the European Commission, and spawned the start of a series of international conferences on Mobile and Ambient Learning. The first fully International Conference was in Rome in 2004 with delegates attending from Australia, Finland, Germany, Greece, Israel, Italy, Spain, Switzerland, the UK and USA.

MLearn 2005, in Cape Town, was a key research and networking event for researchers, strategists, educators, technologists and practitioners from all over the world. Attracting participants from more than 60 countries, the MLearn series has become the world's largest conference on mLearning and emerging ambient technologies.

MLearn 2006, the 5th World Conference on Mobile Learning, in Canada, continued to stimulate critical debate on and research into theories, approaches, principles and applications of mobile devices for promoting learning.

Australia, through the efforts of a small group of enthusiastic professionals, holds a leading position in the development of mobile learning and conferring the hosting of this conference on Melbourne is recognition of the status of Australia within the International community.

mLearn 2007 also saw the formation of the International Association for Mobile Learning. If you would like to receive further information about joining the association, go to **www.iamlearn.caryloliver.com**

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USE OF MOBILE LEARNING TECHNOLOGY TO TRAIN ESL ADULTS

Mohamed Ally; Steve Schafer; Billy Cheung; Rory McGreal; Tony Tin; Athabasca University, Canada

ABSTRACT

The Mobile learning ESL Project provides anyone needing assistance with remedial grammar to complete interactive lessons and exercises so that they can improve themselves to function in the workplace. Students can brush up on their English when they are waiting for a bus, or whenever they want to review grammar. The project provides grammar lessons with interactive exercises to anyone with a mobile device that can access the internet, particularly new foreign workers needing ESL training to enter the workforce, adult learners needing skills update and all other who might want easy access to grammar training. There was an increase in test scores from the pre-test to the post test and to the retention test. Different types of questions were used to test students' knowledge of grammar and to give students practice on grammar. Students preferred the selected-response questions (such as multiple choice) when compared to other question types. Students reported that they liked the flexibility of learning from anywhere and anytime. However, some students commented that the mobile device is too small and they have to become acquainted with the mobile technology. This study will benefit designers who would like to develop learning materials for delivery on mobile devices.

INTRODUCTION

The use of wireless mobile technology such as PDAs, cellular phones, ipods or ultra notebook computers in education and training is making learning more flexible where students can learn from anywhere and at anytime. Mobile learning (mLearning) is novel in that it facilitates delivery of learning to the right person, at the right time, in the right place using portable electronic devices. In the near future, mLearning will become a normal part of lifelong education and self-directed learning.This project developed and evaluated innovative approaches to English as a Second Language (ESL) learning using mobile devices in a variety of learning contexts. The digital ESL content is based on the best selling Penguin introductory English grammar and exercise books which have been released by the author as "open source" (O'Driscoll, 1988, 1990). This project supports research into the adaptation and delivery of learning objects using mobile devices. It attempts to advance the use of information technologies for learning and foster a culture of innovation by providing new evidence-based research into the activities of independent adult learners including, post-secondary students, and other adults in community organizations. Adults learn the basic grammatical tools of English in an interactive modular format, accessible on mobile computing devices. Adults are busy with many family obligations. Allowing adults to learn anywhere and anytime using mobile devices will provide flexibility in learning. This project evaluated the experience and performance of adults using mobile phones to learn English grammar.

LITERATURE REVIEW

Research on mobile learning is a recent development and there have been only a few research surveys conducted (Attewell, 2005; British Educational Communications Technology Agency, 2004; Keegan, 2002; Savill-Smith & Kent, 2003). Preliminary investigations report on the limitations of mobile devices especially the limitations of the small screen size, but also limited processing power, battery life, and memory capacity. Other problems have been encountered because of the wide range in operating systems (Palm OS, Windows CE, Linux) and the differing input devices (Holzinger, Nischelwitzer, & Meisenberger, 2005). Overall, the research on the educational use of mobile devices is very limited and at the early stages. Case studies of different implementations are still needed.

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

have greater confidence in supporting students and increased access to data from anywhere combined with increased efficiency and accuracy (Perry, 2000). Brown (2004) at the University of Pretoria is already proving the value of using mobile phones in the management of distance learning; Taylor (2005) is researching mobile devices use in teacher education in Kenya. White (2004) has conducted research using mobile devices in disadvantaged communities in a developed country.ESL and other languages are also being taught using mobile devices. Song and Fox (2005) found significant improvements in learner performance of language tasks. Others have successfully used mobile devices for teaching pronunciations and listening skills (Uther, Zipetria, Uther, & Singh, 2005). Tense ITS is an adaptive system used for teaching English tenses to ESL learners, with significant positive outcomes (Bull, Cui, Roebig, & Sharples, 2005).Research has also looked at the adaptation of content for mobile learning using learning objects and creating appropriate metadata (Ally, 2004a, 2004c; Friesen, Hesemeier & Roberts, 2005). Learning object metadata for mobile devices is also the subject of research in Europe and Asia (Davis, Good & Sarvas, 2004; Kawarasaki, Ooto, Nakanishi & Suzuki, 2004; Yang, Shao & Sue, 2005). In addition, library systems are implementing international standards-based content for use in mobile environments (Magusin, Johnson & Tin, 2003; McGreal, Anderson et al., 2005; McGreal, Cheung, Tin & Schafer, 2005; McGreal, Tin, Cheung & Schafer, 2005). Research is also looking at the use of intelligent agents for online learning (Ally, 2004b; Esmahi & Lin, 2004; Lin, 2004; Lin & Esmahi, 2004). Baggaley (2004) has researched in the field of mobile teaching and its relationship to mobile learning.

METHODOLOGY
This is an evidence-based research project involving a 'before-after' design following the achievements of target groups using pre- and post- tests on three different subject groups. Subjects were given a pre-test to determine their current level of expertise in English grammar. After completing the grammar lessons, subjects were given a post-test and a retention test. The project was implemented in three different institutions: Global Community College (GCC), Edmonton Mennonite Centre for Newcomers (EMCN), and Evangelical Chinese Baptist Church (ECBC). These institutions had students whose English is a Second Language (ESL). They all completed the same lessons and also filled out a questionnaire to give their opinions on the mobile technology and mLearning.The course content consists of 86 lessons and related exercises teaching the basics of the English language, ranging from the difference between "is" and "are" to verb tenses, countable nouns, and other aspects of basic grammar in the English language. The content is interactive where students are given constant practice using a variety of question types. Four different types of questions were used to make the grammar exercises more interactive, easy to access in the mobile device and to test the students' ability. They were true/false, multiple choice drop downs, changing the order of sentences, and matching. The content is available in adobe pdf and Microsoft word formats and can be downloaded to the desktop and mobile devices.

RESULTS
Over a third of the participants (40%) indicated that they use some form of mobile device (cell phone, smart phone, PDA) on a regular basis. On the other hand, 22% had never used a mobile device. The rest of the participants had used some form of mobile device occasionally. This provides a good mix of participants with mobile device experience to represent a real world scenario. All participants were given access to mobile devices during the study.Students completed three grammar tests during the study. The pre-test was written before the students attempted the lessons on the mobile phones. The average score on the pre-test was 15/20 (Figure 1). The post-test was given immediately following the completion of the ten assigned grammar units. The post-test average was 17.7/20. A retention test, in the same format, was given to the students one week later. The average score was 18/20. A slight improvement was shown after the students accessed and studied the grammar units on the mobile phone. There was further improvement on the retention test which was administered one week after the post-test.
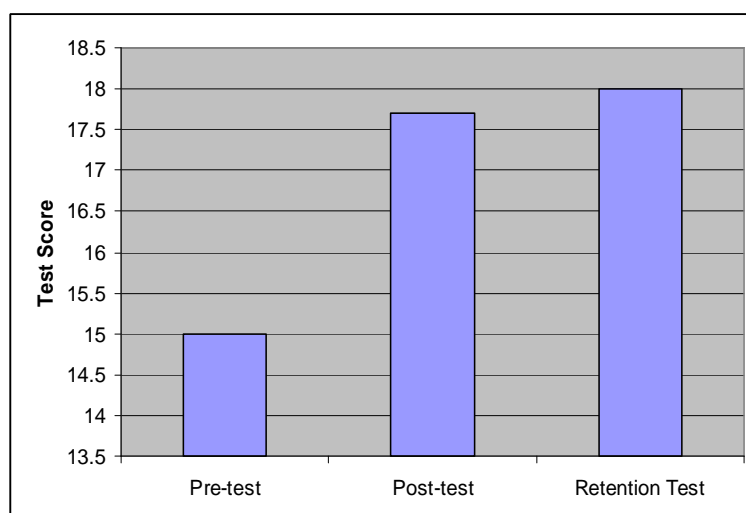
Figure 1: Comparison of Pre-test, Post-test, and Retention Test Scores

Subjects Experience Using Mobile Technology

After subjects completed the ESL lessons on the mobile phone, they were asked to complete a questionnaire to provide feedback on their experience using the mobile technology to learn English grammar. Table 1 shows the response distribution of each question.

QUESTION	STRONGLY AGREE (%)	AGREE (%)	NEUTRAL (%)	DISAGREE (%)	STRONGLY DISAGREE (%)
Information on screen was properly formatted for reading	11	60	29	0	0
This technology provides flexibility for me to learn anywhere and at any time	36	58	2	4	0
Information on screen was easy to read	22	49	20	7	0
Amount of information presented on screen was acceptable	11	53	24	9	0
Input device to enter information was adequate	13	49	27	9	0
The interface to course materials was easy to use	16	62	20	2	0
Learning with mobile technology increases the quality of my learning experience	18	49	27	4	2
The technology was easy to use to access the course materials.	20	58	18	4	0
The use of this type of technology could increase access to learning materials.	20	58	18	2	0
Navigation (moving) through the lessons was easy.	16	53	22	7	2
The graphics on the screen were clear and easy to read.	22	56	16	6	0
I would like to take other lessons using mobile technology.	16	47	22	13	0
I would recommend that other students complete their courses using mobile technology.	16	42	31	7	0

Table 1: Subject Feedback on Use of the Mobile Technology

Most participants expressed a positive experience using the mobile phone to learn English grammar. In the descriptive responses, they indicated that the use of mobile technology for ESL would be a good supplementary medium of learning such as, when waiting for the bus or being on the bus or whenever

there is some spare time. However, participants believed that the mobile devices could not be a substitute for classrooms and more traditional ways of learning through interactions with other students and a teacher is required. However, the flexibility of anytime availability of the mobile ESL materials is certainly appreciated by the students. One major concern expressed over the user of cell phones to access the Internet and the lessons was the cost of Internet access. Availability of Wi-Fi capable phones should address the concern on the cost of access. Additional issues raised by the participants related to the mobile lessons and exercises are listed below.

Use of audio would improve the learning experience

The screen of the phone is too small, which causes eye-strain

Clearer examples would help them understand the questions better

The mobile technology could be used to help student find a teacher to allow him/her to directly interact with the teacher

The cost of internet is too high for the mobile technology to be of any use for them

A suggestion was to make the course more sophisticated. For example, a student should be able to ask whether a given sentence is grammatically correct and should be provided with feedback.

Some of the concerns raised by the students can be addressed by incorporating more sophisticated modules and by focusing more on improving the course site. On the other hand, some concerns such as the size of the screen, are inherent limitations of the devices used to access the site and are highly dependent on what devices the students are using. However, recent development in mobile technology, such as the virtual keyboard and screen, could solve the problem with input device and screen size.

Testing Method on Mobile Technology

Subjects were asked to provide feedback on which type of questions they found suitable for mobile devices. The majority of participants reported that true/false and multiple choice-type questions are suitable for mobile technology. Ninety-three percent of participants thought that true/false questions were suitable for mobile devices while 75% of participants thought multiple choice questions were suitable for mobile devices (Figure 2). Almost half (47%) of the participants found word-ordering type questions suitable for mobile devices. Only 18% of participants thought that matching-type questions were suitable for mobile technology. The main reason given for the least preference for matching-type questions was inconvenience. Matching-type questions posed a need for frequent scrolling back and forth as the screen was too small to fit everything on one screen.
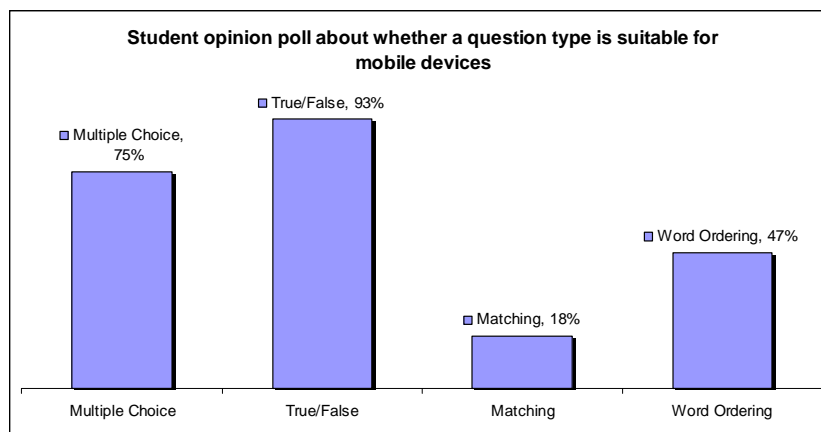
Figure 2: Student opinion about different question types

DISCUSSION

There are many benefits in using mobile technology for learning. One of the most important benefits is learning anytime and from anywhere and providing immediate feedback to students. As students work through exercises one by one, they can receive instantaneous feedback about how they scored (after clicking "Submit" they can find out which questions they got wrong, etc.); and even if they get questions wrong, they can try again and learn from their mistakes. Students can cross-reference to other sites and resources. Mobile devices with constant online access (wireless etc.) enable users to surf the World Wide Web and view related websites that may assist them in their learning.

Using mobile devices to access the online course content increases motivation and opportunity for learning. Having the content online and right at students' fingertips practically just one click away means they can learn wherever they are, despite the constraints of busy work schedules, commutes etc. Moreover, as students achieve success and progress through the exercises, they may be motivated to learn more of the English language

At the same time, they are some limitations in the use of mobile technology in learning. Screen size and variety of mobile devices limits the breadth of formatting and length of exercises that can be reasonably employed for this project. Content has been scaled down in some areas to keep to a smaller word set for exercises. Use of colour/bold/other visual indicators and how this will display on the various devices is less certain, so there are greater limitations on how the content can be presented and coded for mobile phones. Another effect of small screen size is constant navigation between pages, which can make it hard to focus on learning. However, with ongoing development of mobile technology, these limitations can be solved.

A benefit of learning a language is the learning that happens between individuals, or learning in a group. Language learning should provide the opportunity for interaction between students. Mobile delivery of language learning should include opportunities for students to talk to other students and the instructor to practice their language skills.

CONCLUSION
Computers are becoming an integral part of teaching languages. More and more people are using internet capable mobile devices such as cell phones and PDAs. Using these already widespread devices for teaching/learning activities can be an attractive option for busy people. They could utilize their spare time for productive usage such as learning grammar, when they are away from school and home. It helps them to better utilize their time which they would waste in mundane activities like waiting for a bus, or playing a game on their cell phones.

Providing opportunity for using their mobile phones for learning in their private time allows their learning to be individualized to some degree; if they are having trouble with a section, they can re-read it and do the exercises again without fear of delaying their fellow students (or asking embarrassing public questions). If they are feeling confident in a section, they can skip it and not face sitting though a redundant lecture from the teacher.

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A COLLABORATIVE MLEARNING ENVIRONMENT

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ABSTRACT

This paper presents the Mobile and Ubiquitous Learning project (MoULe). This project aims to support students using context sensitive handheld devices in collaborative knowledge construction. To achieve this aim, a learning platform called the MoULe environment has been designed, which permits users to edit and share documents and conceptual maps using desktop computers and smartphones equipped with GPS. Teachers can use this environment to organize situated learning activities which connect digital resources to geographical locations. The MoULe project intends to facilitate the creation of learning communities who collaborate in the construction of an augmented reality where digital objects are related to physical places. The digital objects created by the students are wiki pages and conceptual maps and all the information in these documents are location based. The initial testing phase of the project involved teachers and students from four high schools in Palermo (Italy). In the paper the MoULe project and the MoULe environment are presented with some preliminary considerations about the didactic activities carried out.

Author Keywords

Mobile Learning, Collaborative mLearning Environments, Online Learning Community, Situated Learning

INTRODUCTION

The last few years have seen an increased use of mobile technologies within schools and other educational contexts (Rivero, 2006). This trend will probably continue in the coming years; the ADS2006 (America's Digital Schools, 2006) report predicts, on the basis of a large scale survey, that by 2011 about half of all computers used in schools will be mobile. The growing number of didactic applications for mobile devices also reflects the transition from desktop to handheld computers.

Many researchers have therefore tried to understand the impact that these technologies can have on learning processes, and to study the pros and cons of their wider diffusion in the educational field.

An analysis of the literature reveals an evolution over time. Early studies focused on technological aspects and especially on the use of mobile devices in the classroom while later research has concentrated on pedagogical aspects. The most recent studies consider the use of mobile technologies in relation to a wider view of the learning experiences, which are often based on innovative methodologies where learning is seen as continuous process, which takes place both inside and outside the classroom.

Pownell e Bailey (Pownell and Bailey, 2001) highlighted the role of handheld devices in increasing familiarity with the use of new technologies, on the part of both teachers and students, so that these devices can help increase innovation within schools.

Crowford e Vahey's report (Crawford and Vahey, 2002) emphasizes the advantages of using these technologies as well as some of their drawbacks like the inappropriate use which students often make of them and issues of reliability and usability which are still to be resolved.

This study and others (Norris and Soloway, 2004) concentrate on the opportunities for peer-to-peer communication and collaboration provided by these devices, summarized by the motto "*swivel in your seat and beam*".

In these initial studies the mobile was still considered only as an important means for motivating students and not as a challenge requiring the elaboration of specific didactic models.

In the most recent research we observe a change of prospective and a theoretical search for new educational models becomes the focus. An updated review of the main methodological approaches applied to mobile learning can be found in (Naismith et al., 2004). The authors emphasize how the use of mobile devices adds new opportunities to education, because they are personal and portable and permit new forms of interaction between everybody involved in the learning process and with their surrounding environment.

Moreover Wishrat (Wishart, 2007) considers that the didactic activities based on these tools must be rooted in a constructivist approach and she claims that one of the strengths of using such devices lies in the possibilities they provide for carrying out meaningful experiences of situated learning, especially when equipped with GPS. The use of these systems allows students to reinforce the link between concepts and the context in which they learn.

Some projects which apply a similar approach include:

- *'Scape the Hood* (coordinated by the KQED Digital Storytelling Initiative, USA, the web site address is http://dsi.kqed.org/index.php/situated/C59/) aims to provide the user with a personalized and unique experience of the environment and neighbourhood in which he is moving. The handheld devices, equipped with GPS, provide digital multimedia contents to the user depending on his geographical location at a particular time. The project uses the point of view of *Narrative Archeology* (Hight, 2006).
- *Enviromental Detectives* (coordinated by the MIT Teacher Education Program's Handheld Augmented Reality Simulations, the web site address is http://education.mit.edu/ar/index.html) is an *Augumented Reality game* in which the students can use a pocket PC with GPS to investigate the causes of environmental disaster, simulated on the PC.
- *The Chawton House Project* (part of the *Equator* project, the web site address is http://www.equator.ac.uk/index.php/articles/1218) is centred on old residence in Hampshire (UK), where there is a library dedicated to the works of English women writers. This residence has been technology enhanced so that users and students with location-sensing devices can visit it and use it for learning purposes. The project has thus implemented a "*persistent infrastructure*" (Weal, 2006) in which different mobile learning projects can be housed.

An other important aspect explored in recent literature is the development of projects of *computer-supported collaborative learning* (MCSCL) (Zurita and Nussbaum, 2004). This research shows that handheld computers provide students with "at hand" support to engage in collaborative activities anytime, anywhere.
Further projects in this field are:

- *CatchBob!* (coordinatet by the CRAFT – Center for Research and Support of Training and its Technologies, Swiss Federal Institute of Technology Lausanne, web site http://www.i-cherubini,it/mauro/projects/MapTribe) aims to study how the perception of space and places can influence the collaborative learning processes (Nova and al., 2006).
- *Charles River City* (coordinated by the MIT Teacher Education Program's Handheld Augmented Reality Simulations, USA, site http://education.mit.edu/ar/index.html) is another *Augumented Reality game* similar to *Enviromental Detectives* except that environment simulated on the pocket PC is more dynamic and flexible where the students can communicate in real time and modify the setting and their roles.
- *Create-A-Scape* (coordinated by the Futurelab, UK, site http://www.futurelab.org.uk/) is a web site which provides tools and assistance to students and teachers who want to create mediascapes, or rather a collection of location-sensitive images and sounds placed on a PC map, so when a user visits the physical location carrying a Personal Digital Assistant (PDA) he will be able to see and listen to them.

Other projects aiming to promote collaboration between users by means of interactive maps are for example:

- *MapTribe* (coordinated by the CRAFT – Center for Research and Support of Training and its Technologies, Swiss Federal Institute of Technology Lausanne, site http://craftwww.epfl.ch/research/catchbob) is a software application which allows users with mobile phones to see the positions of the other users on a map and to add and share objects indicated on the map (Cherubini and Nova, 2004).
- *Ubicomp Navigation*, (coordinated by London Knowledge Lab, UK, site http://www.lkl.ac.uk/cms/) aims to develop new methodologies to assist users during navigation in *ubiquitous computing* environments, or rather environments where digital and physical information are both present (Papadogkonas at al., 2006).
- *GPS/GIS Community Mapping* (coordinated by the Wireless Education & Technology Center della California State University Monterey Bay, USA, site http://wetec.csumb.edu/site/x17445.xml) is a collection of tools for collaborative elaboration of maps, in real time, using wireless PDA devices.

In this paper we present an mLearning project named MoULe, Mobile and Ubiquitous Learning, carried out at the Italian National Research Council. MoULe adopts most of the methodological and technological solutions described above. In fact, the MoULe project allows users to carry out collaborative learning activities both online (through a learning management system) and on site (using

applications on mobile equipment). In order to test and validate our theoretical assumptions on mobile learning, we have developed a learning platform, called *the MoULe environment*, based on the integration of a Learning Management System with specifically designed mobile applications.

In the following sections, we will illustrate the objectives and methodologies that have guided the design of the MoULe project; then, we will present the MoULe environment, highlighting the learning mechanisms enabled by the environment, and how these mechanisms reflect the methodological approach adopted in the MoULe project; a use scenario complements this section; finally, we will shortly describe how the MoULe environment has been used in a 4-month learning experience with 80 high school students.

THE MOULE PROJECT

The aim of the MoULe project is the implementation and experimentation of an innovative learning environment that allows users to overcome the space-temporal limitations of classroom and laboratory activities. In the MoULe project we would like to explore and evaluate the ways of using mobile devices to support learning, enriching the usual learning experience through the specific features supplied by such technologies.

The possibility of using mobile devices to communicate and interact with other users who share the same experiences means that social interaction moves increasingly from the classroom to everyday places where real life experience is an unbeatable stimulus to learning.

Moreover, the MoULe project is strongly based on student mobility and on contextualized information. In fact, mobility means being in and moving around the places which are the object of study; while contextualization is very important because the student's geographical position changes the learning context and consequentially the students' learning experiences.

In the MoULe project we used smartphones supplied with GPS in order to link all the activities carried out by the students with a specific location inside an area of interest. The goal is to track students during the whole collaborative knowledge building process, and reconstruct the physical exploration of their learning space. In this way the student activities create an augmented space consisting of physical objects as well as the didactic objects/items they produce.

The augmented space, which is represented through a geo-conceptual map, enables the transformation of a city tour into a real educational experience.

To achieve this we have integrated the functionalities of the e-learning environment with the functionalities that are used to design, implement and manage the mobile learning activities. The goal was to create a single system in which on site learning activities can be alternated with classroom learning activities, so that the knowledge building process is supported in both learning environments.

In order to promote the learning strategies presented above, in the MoULe project we have foreseen the definition of specific learning environments to support the achievement of the learning goals; the setting up of a learning environment in MoULe means activating specially designed functionalities that can be accessed through mobile devices or desktop computers.

In particular, the MoULe project supports learning mechanisms based on:
- collaborative knowledge building through representation schema based on conceptual maps.

- collaborative creation of hypertextual documents.

The conceptual maps are one of the most important examples for the activation of knowledge building processes. They improve the development of metacognitive abilities on which human learning is based. Their didactic use has been proposed by Novak and Gowin in the 1970s (Novak and Gowin, 1984). The contribution made by these researchers is based on the idea that the graphical knowledge representation forces the students to reflect on the concepts and on the relationships that exist between them.

In the last few years attention has focused on the study of the potentialities of didactic tools in the collaborative construction of conceptual maps: *collaborative concept mapping*, or CCM (Basque and Lavoie, 2006).

The collaborative use of conceptual maps is a natural extension of the pedagogical paradigms presented above towards strategies centered on educational social networks. The prospect of using these experiences in real learning contexts (situated learning) is an attractive idea, since an initial conceptual map can be improved as a result of student experiences in a learning path carried out on site. One of the

most representative studies in this field is the research carried out by (Sharples et al., 2003); they describe the implementation of tools for the use of this type of methodology through mobile devices.

In the MoULe project the collaborative construction of hyper-textual documents is based on the use of wiki. The central idea of wiki, a technology developed by Ward Cunningham in the 1995 (Cunningham, 1995; Leuf and Cunningham, 2001), is the creation of web pages in a collaborative way where web pages are freely editable by all users of the net. This approach has had a wide reaching success; currently the most important application based on wiki is doubtless the wikipedia encyclopaedia which collects contributions from users all around the world. The paradigm that wiki uses for web page construction has many similarities with social constructivism and shared knowledge building theories, which are at the basis of the MoULe project.

According to social constructivism, knowledge is not transferred from teacher to student, but is the result of a collaborative building process that takes place through collaborative and social negotiation. From this point of view it is extremely important to consider the temporal and spatial aspects of the interactions, and for this reason the use of mobile devices to access collaborative tools such as wiki, plays a central role in this research field.

Unlike the activity based on the construction of conceptual maps, where each concept inserted in the map is contextualized in an existing network, the use of wiki space makes it possible to build information more freely; when students intervene in a wiki space to modify or integrate the contents with new information, a learning mechanism based on real collaborative knowledge building is established.

THE MOULE environment
The project has been implemented by means of a software environment accessible both through desktop computers, used by students in the classroom or at home, and through mobile devices during on-site learning activities.

The resources produced during both activities are associated to specific geographic locations, called *points of interest* (POI). Each POI does not indicate a single geo-referenced position, but a set of spatial coordinates that represents a geographical area, for example cultural heritage sites or archaeological sites related to the learning activity. In this way the two collaborative activities identified in the previous section, the construction of conceptual maps and hypertextual documents, are always connected to the physical sites represented by POIs.

Access to the system from the computer desktop is provided by a specific module of the learning management system Moodle (Dougiamas and Taylor, 2003). Using this module teachers can design a MoULe activity, defining the POIs, the learning objectives and the functionalities that students can use during their learning activities. In particular, students can use tools to create and edit wiki pages, build and share conceptual maps, make personal notes, communicate with peers and perform search tasks.

We wish to highlight that the innovative methodology that we propose in this project has as its main learning goal the collaborative construction of wiki pages and conceptual maps while the other functionalities listed above are necessary to support two important characteristics of the proposed methodology:
1. the close relationship between physical objects and digital objects created during learning activity.
2. collaboration among students to build knowledge in a shared and motivating way.

With mobile devices students have the same functionalities of the Moule environment as those available on desktops, but with the use of GPS technology the association between the resources and their geographical location is not apparent.

In the following sections we present the tools that can be accessed by students, both from desktop computers and mobile devices.

Conceptual Maps
The MoULe environment provides users with a set of functionalities for the collaborative construction of conceptual maps on a topic proposed by a teacher, a student or a group of students.

Through the system interface available in the Moodle platform it is possible to propose a research topic, for example the comparative study of the architectural styles of the cultural heritage sites situated in a

specific area, and highlight the principal concepts related to the topic as a starting point for the students' work.

Starting from this initial map displayed by the mobile device the students can use the functionalities provided by the mobile application in order to:

- expand the content of the nodes already present on the map through an in-depth examination of the related concepts;
- expand the map by adding new concepts logically related to the nodes already present on the map;
- identify new relationships between nodes already present on the map and link them.

The users can synchronize the map on their own mobile device with the map on the server, publish their own modifications and obtain the modifications made by the other users.

Finally, the system traces the contributions provided by each user so teachers can evaluate the results of the learning process, highlighting the meta-cognitive aspects of the knowledge building process.

Wiki

The MoULe environment allows users to produce hypertexts collaboratively by means of the wiki, as a result of the learning experiences that take place in the classroom and, especially, during on-site visits.

The wiki module allows users to link each page with the POIs related to the content of the page. In this manner a semantic layer is built that automatically links the contents with the POIs allowing users to navigate and analyze the contents not only through the usual hypertext links but also considering the physical sites involved in the study. Moreover, the students can add the notes taken during their visit into the wiki pages.

We want to stress that the knowledge space and its hypertextual structure is not designed a priori but students can add new pages and new links between pages.

As for the conceptual map tool, users can synchronize the wiki on their own mobile device with those on the server, publish their own modifications and obtain modifications made by the other users.

The MoULe environment allows teachers to manage the knowledge building process through specific tools that provide mechanisms for evaluating the learning activity in progress. For example, the teacher can:

- analyze each students contribution to the construction of the hypertext, identify the new pages he/she has added or the old pages he/she has modified;
- verify the interest of each student in a specific area of the research topic, for example the teacher can check if a student has visited only a sub-set of pages linked to a specific POI;
- intervene actively in the knowledge building process, editing the contents of the pages or controlling the building process, on the basis of the pedagogical working hypothesis.

Contextualized notes

When students visit a site as part of their learning activities they can use mobile devices to gather textual contents, images, video and audio recording. The environment allows students to annotate the media they collect in order to classify them and thus facilitate their search and reuse in the collaborative activities supported by the environment. In particular, with reference to the wiki activity, these contents can be directly inserted into the wiki pages; while with reference to the conceptual map, implementing the idea developed in the FLE3 project (Muukkonen et al., 1999; Leinonen, 2003) in mobile devices, the environment facilitates the creation of a knowledge tree/graph/map. Moreover, the environment has a tool that shows a map with all the notes collected by the students. Through the map it is possible to view the notes and the location in which the notes were taken.

Asynchronous and synchronous communication tools

The MoULe environment supports asynchronous and synchronous communication between students by means of specific tools designed to facilitate user interactions. In particular, students located in the same area can exchange messages or multimedia contents in real time and access a virtual whiteboard in which other students have left their notes.

The synchronous communication tools are implemented by means of an instant messaging system used by the participants in the learning process to exchange messages and textual or multimedia notes in real time. For example, a user can take a picture or create a note and send it to the other users connected to the system. The communication can be one-to-one or one-to-many. The environment also provides a

virtual room for each POI: students in the proximity of a POI can communicate with the other students in the same area by entering the corresponding room.

With regards to asynchronous communication, the MoULe environment provides two main groups of functions: message exchange in textual or multimedia format and shared whiteboard access. In the first case users send messages to a user or group of users using gateway technologies from mobile to Internet e-mail. In the second case, it is possible to enter a shared archive of notes where students are both authors and users of the contents according to the knowledge building paradigm. Each media can have localization information associated with it, so it can be retrieved more easily even in contextual searches.

Contextualized Search Engine
The search features provided by the MoULe environment can support the students during the visiting experience. Bearing in mind the limited hardware resources of mobile devices, we have developed a user friendly interface that enables users to find the information they really want in only a few clicks, thus avoiding the risk of students getting "lost in hyperspace".

To achieve this, we have developed a specialized search engine that looks for information about POIs involved in the learning activity. There are certain reasons for using a specialized search engine since, even though generic search engines are the most used, they present some limitations when carrying out a task in a particular category.

The quality of the results generated by a search engine which is specialized in a particular topic is usually better than a general one. There are several reasons for this: first of all, a specialized search engine has a smaller and more manageable index because the indexed pages are fewer in number, and consequently a specialized search engine can crawl the pages more frequently.
The MoULe search engine allows users to access updated information and obtain a set of semi-structured data from the analysis of a set of information sources such as:
- a platform repository, made up of all the contents gathered by users during their activities;
- a set of information sources on the web validated by the teachers;
- and the web in general.

Moreover, from the GPS localization, the system can find the geographical position of the student, recognize the cultural sites that the students are visiting and show a set of pre-defined specialized queries concerning the site.

Figure 1: The MoULe in action on the mobile device

Monitoring

The actual position of the student during their outside activities is shown by the MoULe environment using the position taken by the GPS system of the mobile device, and a map providing service of the popular search engine Google. Using the monitor module, a MoULe user (student or teacher) can:

- observe the path of the students on site;
- send an instant message to a student located on the map.

A MoULe scenario

In order to describe a typical MoULe system scenario we imagine a possible interaction between two students called Giuseppe and Maria, who use the MoULe environment to build a wiki page collaboratively; Giuseppe uses a desktop computer wired to the Internet at school while Maria uses a mobile device on site with an Internet wireless connection supported by a GPS aerial. Their learning activity is focused on "Pretoria square", a public square in Palermo, where two POIs, "poi1" and "poi2", are situated.

After the two students have signed into the system and chosen the same MoULe activity, Giuseppe sends Maria a MoULe instant message, asking her to take some photos of poi1; then Maria, who is near Pretoria square, receives the message and goes to poi1 guided by the MoULe navigator. When she arrives in the proximity of poi1 the system notifies her with a visual and audio signal that she is entering the "point of interest" area. Thus, Maria can now take some photos of poi1 using the built in MoULe tool for multimedia notes. The acquired photos are automatically associated to poi1 using the GPS location data, and Maria can decide to publish the photos on the MoULe system, and share them with her class mates. At the same time, Giuseppe who is at school, builds a new MoULe wiki page focused on Pretoria square, where he describes the square and uses the multimedia notes published by his class mates. In particular, he can add the audio track, image or plain text notes acquired on site and published by Maria. Giuseppe decides to use the MoULe search engine in order to obtain more information about the learning goal. He has access only to the web documents connected to Pretoria square and especially to poi1 and/or poi2. Thus, Giuseppe can improve the description of the wiki page he is editing by adding the information he has found.

Giuseppe can monitor Maria's location in Palermo at anytime by viewing a map navigator which shows the position of his class mates who are on site around Palermo.

In addition, Maria can use her mobile device, to access the wiki page created by Giuseppe, and edit the document. Moreover, using the localized search engine, Maria can add textual information to the poi2 description. Finally, Maria and Giuseppe meet in the chat room to agree on the final changes to the wiki page.

THE MoUL E IN ACTION

The MoULe system was tested with teachers and students at high schools in Palermo for four mouths. The testing was designed in two phases: first we tested the prototype with the teachers and then about eighty students were involved.

In particular, the first phase involved fifteen teachers of different subjects (science, arts , languages) from four schools in Palermo. The group was introduced to the methodology and technology of mobile learning and then instructed in the use of the MoULe environment to build the collaborative knowledge activities described above. Moreover, the teachers designed the learning activity and the itinerary for the second phase involving students.

This latter phase involved about eighty students from two secondary schools, one specializing in pedagogical subjects and the other in tourism. Two fourth year classes were selected from each school. Unlike the first phase where 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 designed in the first phase which varied according to the type of school. In fact, the students from the pedagogical school followed a "historical street markets" itinerary, while the students from the tourism school followed a "baroque age" itinerary. 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 tourist guides in different languages about the sites they had visited.

CONCLUSIONS

Since the middle of the last century, colleges and universities have been offering distance education programs; with the advent of the Internet era, the on-line offer has been growing at dramatic rate. More recently, mobile technologies have entered schools and other educational settings, thus widening the opportunities for on-line learning solutions. Specifically, recent studies have analysed the potentials of using mobile technologies in relation to learning experiences which take place both inside and outside the classroom.

In this paper we have introduced the Mobile and Ubiquitous Learning project (MoULe), an mLearning project based on the principle that the use of mobile devices is particularly suitable for integrating traditional learning activities with situated learning experiences. From a theoretical perspective, the MoULe project focuses on the concept of collaborative knowledge building and on the socio-constructivist learning paradigm.

The project has been implemented by means of the MoULe software environment accessible both through desktop computers, used by students in the classroom or at home, and through mobile devices during on-site learning activities.

The MoULe environment is based on the integration of a Learning Management System (LMS) with specifically designed mobile applications; it allows users to collaborate and learn in a different way from traditional LMSs, anytime and anywhere. In particular, the MoULe system supports the collaborative knowledge building through conceptual maps and collaborative creation of hypertextual documents. Finally, it gives users the possibility to collaborate and learn "on site".

The MoULe environment has been used by one hundred users (teachers and students) of two high schools in Palermo (Italy) during the regular curricular time. The students have tested the MoULe system for three mounts (from March to May 2007) using desktop PCs at school and/or home, and smart-phones and PDAs on-site (guided visits around the centre of Palermo). The preliminary results have highlighted a general improvement in the student knowledge as well as in students and teachers

motivation in using the technology. However, this testing phase has also shown some system drawbacks mainly related to the limited bandwidth connection guaranteed by the provider of the mobile communication infrastructure. The MoULe project foresees a double testing phase, so that it will be further evaluated next autumn. Data gathered during both the testing periods will be analysed, in order to better specify the impact of the mobile technology on students' learning.

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LEARNING INFORMAL SCIENCE WITH THE AID OF MOBILE PHONES: A COMPARISON OF TWO CASE STUDIES

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ABSTRACT

Research trends indicate that informal science education could benefit from mobile learning. Yet, very few science centers offer it. In this paper, we report on two science centers that are using mobile phones to enhance visitor learning. The projects are in-progress, yet well-documented. Liberty Science Center is eight months into a three year government grant and Anne Kahr- Højland is in the middle of her Ph.D. work at the Experimentarium. Together, these projects mark the beginning of the knowledge base for informal science learning aided with mobile phones. The purpose of comparing these two case studies is to provide helpful indicators to other science centers looking to implement mobile learning initiatives.

Author Keywords
Mobile phone, m-learning, informal learning, science center, SMS, MMS

INTRODUCTION

More and more visitors are walking into museums with their own powerful mobile technology—their phones. Thanks to advances in processor and memory chips, mobile phones are not just for talking anymore; they are complete multimedia centers combining the capabilities of a still and video camera, personal organizer and Web browser all into one device (Marriott, 2005; Stone, 2004). Being a multimedia powerhouse is only one of the phone's advantages in the mobile learning world. Since museum visitors own their phones, they are familiar with the user interface and can easily direct their m-learning experience. Visitor ownership also presents financial and logistical benefits to museums. The costs of upgrading, maintaining or distributing the devices are minimized because the institutions are not relying on renting out equipment.

Given all that, it's no wonder that Scanlon, Jones and Waycott (2005) "reviewed the trends in contemporary science learning and identified a number of current trends which suggested that mobile learning in informal settings had particular benefits to offer." Unfortunately, despite all the powerful reasons to pursue mobile phones as a learning platform, the number of science centers investing in m-learning initiatives is miniscule.

Part of the hesitation could be due to the absence of a conceptual framework for how to implement an m-learning initiative in informal science education. This paper presents two case studies of projects attempting to contribute to that body of knowledge. The conceptual framework doesn't exist yet because the knowledge base is too small. More science centers need to create and implement m-learning projects in order to grow the knowledge base.

These two projects, which are being developed in a relatively unexplored learning environment, represent the first of their kind. These case studies represent the first significant research and development efforts for using the mobile phone as a technical platform for learning in science centers. Comparisons are drawn to serve as helpful indicators to other science centers looking to implement mobile learning initiatives.

PROJECT #1: EXTENDING THE MUSEUM EXPERIENCE

With grant funding from the United States National Science Foundation, a mobile phone-facilitated learning companion has been designed and will be implemented at Liberty Science Center (LSC), located in Jersey City, NJ, USA. When the newly renovated science center reopens on July 19, 2007, visitors will use their mobile phones to interact with exhibits, retrieve extra content, and extend their learning experience. This mobile learning initiative is called Science Now, Science Everywhere (or SNSE, pronounced sen-say).

Originally conceived in January 2005, SNSE started off as a mobile learning experiment with PDAs, MP3 players and mobile phones. But after meeting with an advisory committee and contracting a Front-End evaluation, LSC realized that the kind of learning they wanted to create would best be facilitated by the mobile phone. Mobile phones were absorbing PDA functionality and MP3 players didn't have the capacity for instantaneous downloads or two-way communication. The evaluation findings showed that a

great majority of visitors (84%) brought mobile phones with them to the science center (Haley Goldman and Foutz, 2005).

It became clear that teenagers should be the targeted user group when the Front End research showed that teenagers had a higher than average interest in every mobile phone activity that was evaluated (Bressler, 2006). Six out of a list of ten activities were rated 7.23 or higher on a 10 point scale. The lowest rating was 6.00 for the audio tour.

LSC hosted a symposium in June 2005 so museum colleagues could discuss the potential of mobile devices for enhancing museum learning. Many attendees were hoping to implement mobile-based learning initiatives. The overwhelming reason for starting such projects was providing a visitor-directed tour. Yet, during brainstorming sessions, attendees envisioned much more exciting possibilities, such as visitors interacting with the content through their devices and even taking content away with them on the devices.

LSC implemented a series of public prototypes for initial testing. All prototypes were built around the "tour" concept. Signal strength was identified early on as a problem. This problem will be solved with cellular repeaters, a hardware solution that repeats the radio signal coming from nearby cell towers so cell phones have improved reception inside buildings. Appropriate signage was a problem too. Either visitors didn't notice the signage or they had trouble with the instructions. LSC is increasing signage and will continue to test the effectiveness of the instructions during Formative evaluation later this year. Visitors were also very protective of their cell phone minutes, so LSC is implementing a selection of different SNSE activities including audio, SMS and MMS possibilities. SMS stands for Short Message Service, commonly known as text messaging. MMS, or multimedia messaging service, enables phones to send messages that include multimedia objects, like pictures or videos. While SMS and MMS often incur extra charges, focus group research showed that teenagers were apt to have unlimited plans for those functions.

Starting, July 19, 2007, when the science center reopens, SNSE will be highlighted in three exhibition galleries: *Eat and Be Eaten*, *Communication* and *Breakthroughs*. In the *Eat and Be Eaten* exhibition, visitors will examine the appearance, behavior and physiology of over 20 different species including a variety of reptiles, fish and insects. In *Communication,* guests will explore the human and the technical sides of daily communication. Visitors will learn about the social and ethical issues posed by new scientific discoveries in the *Breakthroughs* exhibition. There will also be one museum-wide experience known as the camera phone challenge. Similar to a scavenger hunt, visitors collect pictures from around the museum to complete a challenge.

When visitors arrive at the Liberty Science Center, they will be encouraged to sign up for SNSE using their own mobile phone. However, if a visitor does not have a phone, they can borrow one from the science center. To subscribe, visitors simply send in a SMS message and the system will reply to confirm the subscription. SNSE subscriptions are free; however, normal SMS rates apply. Once subscribed, visitors can easily use any SNSE experience.
At the most basic level, SNSE offers audio information. Graphics in the exhibitions will indicate the phone number to call and the four digit code to use. Listening to SNSE will give the visitor information to think about as they are observing animals and artifacts. Visitors will also interact with SNSE through SMS. Using SMS, visitors can contribute information to exhibit displays and control moveable elements in the exhibits. Finally, SNSE has some MMS components. The camera phone challenge uses MMS to send pictures back to a website for collection and comparison. Also, there is a station in the *Communication* gallery where visitors can create an image and save it to their phone.
In addition to the implementation of the technical system, the project is hosting an online resource (http://snse.lsc.org). Planned symposium will also be hosted by Liberty Science Center for professional colleagues to hear about related work in the museum field, review detailed research findings and try the SNSE system.

SNSE is a collaborative project led by Liberty Science Center. Denise Bressler, SNSE Project Manager at the science center, created the theoretical framework. As part of the grant funding, there are two research partners. The Center for Mobile Communication Studies, located at Rutgers University, NJ, USA is conducting longitudinal work with teenagers. The Institute for Learning Innovation is conducting

Formative and Summative research which includes interviews with visitors at the science center and follow up phone calls. Researchers at both organizations will seek to understand the impact of SNSE on target audiences and will work towards developing an understanding of design criteria that can be used to create successful informal science m-learning experiences. The result of the collaboration will be the development of criteria for success that will guide the LSC staff as they incorporate m-learning experiences into their permanent galleries.

Several contractors were hired to implement the SNSE system. Onomy Labs designed the backbone of the SNSE system which handles subscribers. They are also responsible for several exhibits where visitors can use their phone to interact with exhibit elements. Chedd-Angier-Lewis and Swim Design have worked with Liberty Science Center and Onomy to develop the additional SNSE experiences. Lastly, Caterpillar Mobile is responsible for the camera phone challenge. Lucent Technologies and Verizon Communications are providing technical guidance.

By October 2009, after three years of grant funding, the project will have developed, installed and evaluated the SNSE mobile learning system as part of three exhibition galleries. Research gained will be synthesized and distributed as criteria for successful implementation of m-learning experiences in informal science education. These criteria will guide Liberty Science Center staff towards incorporating m-learning experiences into other exhibition galleries.

PROJECT #2 INTERACTIVE NARRATIVE WITH AN EDUCATIONAL AIM
As part of an on-going Ph.D. project, a mobile phone-facilitated interactive narrative has been designed and implemented at the Experimentarium, a science center in Copenhagen, Denmark.
In 2003, Anne Kahr-Højland did her master's thesis in Educational Theory. The thesis investigated how a narrative holds great potential as a way to communicate scientific information. She conducted her research at the Experimentarium. Kahr-Højland then applied for a Ph.D. project about how to make an "intelligent exhibition" at the science center. She soon decided to change from the word "intelligent" to "personal" in order to build on her master's work about narratives. In order to make a personal exhibition, she needed a personal technology to facilitate the interactive narrative. She chose the mobile phone because she felt it would facilitate a personal connection to the exhibition without disturbing the narrative. It was also a technology that young people were very familiar with and something they always had with them.

Similar to SNSE, Ego-Trap is also a collaborative project which is part of a permanent exhibition at the science center. Anne Kahr- Højland, a Ph.D. student, created the theoretical framework and will be conducting on-going research. The Experimentarium, the science center, developed the interactive narrative based on Kahr- Højland's theretical specifications. Michael Valeur, a script writer, was hired to write the narrative. He worked closely with Kahr- Højland and the Experimentarium. UnWire, a technical consultant, created and implemented the technical solution which includes mobile internet, Bluetooth and a computer server.

The name of the experience is Ego-Trap – the cell phone is your key. It opened in March 2006. Visitors need to have a cell phone with mobile internet access. Let's say John Smith decides to do the Ego-Trap experience.
Level 1: To begin, John signs up with his name, age and cell phone number. The system calls him back a few minutes later. A woman's voice welcomes John and prompts him to use certain science exhibits. John navigates through the science center using a map displayed on his phone. John uses a series of exhibit elements dealing with tone recognition, arm strength or spatial awareness. At each exhibit, the woman asks John to guess how well he thinks he will do. He replies by using the phone's keypad. The woman's voice evaluates John and—based on how well he did—provides him with his visitor profile. She then tells him there is someone in the exhibition who matches his profile. If John agrees to meet his match, the experience continues. If John declines, the experience ends here.
Level 2: John continues to listen to the woman's voice as he tries out exhibits that require cooperation with the person who matches his profile. Again, John is asked to anticipate how well he will do at each activity, which is followed by the woman's assessment. Suddenly, John receives a phone call from a person who claims to have hacked into the system. The caller explains to John that he is part of a dangerous experiment. The woman who is guiding him is evil. If John believes the caller, the experience continues. If he believes the woman's voice, the experience ends.

Level 3: The caller gives John the code to enter a secret room. The door closes behind him. Inside, John finds an animated rat who sounds exactly like the woman on the phone. It appears that the rat has mutated and taken control over a science lab. The rat is conducting experiments on human beings and John has been captured. To gain his freedom, John has to play a game against the rat. (The game is designed so that it is easier and easier to win; therefore, participants will win and be freed at some point.) Upon winning the game, the experience is over.

The project is investigating young people's experiences and reflections in an informal scientific context (Kahr-Højland 2006). The research aims to answer the question of how to design and use an interactive narrative in an informal learning setting with the aim of urging young people's scientific interest and activate their scientific literacy.

Close monitoring during the first eight months showed that the system functioned well technically. The only problem was that the personal profile that was supposed to be given at the end of Level 1 was not given to visitors. This problem has been fixed. The project team also decided to make a few small changes like putting in an extra step if the visitor wanted to log off. This helped to avoid involuntary departures from the game. Additionally, they reduced the number of exhibit elements that visitors needed to use during the first level to decrease the overall duration of the experience.

From November 2006 to January 2007, students using Ego-Trap were observed, video recorded and interviewed. (Complete synthesis of the data is not available yet.) General conclusions include that the students found the experience exciting and engaging. Even the students who spent the longest time with the activity still found the experience to be interesting and not boring. None of the students found the mobile phone awkward to use in this type of experience. Since teenagers are the "archetypal mobile superusers" (Ling, 2004), these conclusions are not surprising. However, there were a few unexpected results. Students seem to remember their interactions at the exhibits vividly, with much greater detail than the overall story. Some of the students did not understand that the rat was the woman who was guiding them through the exhibit elements. The rat story was less interesting then testing themselves at the exhibits. However, they were very engaged with the part of the story where they followed the advice of the hacker—and no one doubted that they would do so.

CONCLUSION

These two case studies represent works in progress. Further research will be forthcoming from both these projects. Liberty Science Center is eight months into a three year government grant and Kahr-Højland is in the middle of her Ph.D. work. However, together, these projects mark the beginning of a very interesting area of informal learning aided with mobile technology. Therefore they are worthy of comparison.

Both projects are working towards an understanding of how the mobile phone can be used to enhance the learning experience in informal science education. Both projects encourage visitors to use their own mobile phone in an attempt to give control of the learning experience to the visitor. This makes sense given the philosophy of science centers to promote interactive exploration and free-choice learning. Comparing some initial research from both cases, it is clear that young people are the most sensible target audience for mobile learning initiatives. Teenagers seem to have interest in doing anything with their phone. Since these projects embody very different interactive experiences; the mobile phone seems to represent almost limitless educational possibilities for science centers. Both projects are three-way collaborative partnerships between a science center, a research partner and a technical partner or group of technical partners.

Both projects had a gestation period prior to implementation. There may be a variety of reasons for that period, however, other institutions wishing to implement m-learning initiatives should take note. There is no conceptual "framework which will allow us to consider complex settings in depth and understand how to track the impact of altering the learning infrastructure by introducing a mobile technology" (Scanlon, et al. 2005). We are at the beginning stages of understanding how m-learning can work in the context of science centers.

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MOBILE BLOGGING: A GUIDE FOR EDUCATORS

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ABSTRACT

This paper provides a short overview of the nature and educational usefulness of blogging, followed by an overview of the various mobile blogging and RSS reading options available today. The paper serves as a practical introductory guide for educators interested in implementing mobile blogging. The emphasis is on keeping it simple, so that the technology does not get in the way of the pedagogy.

Author Keywords

Mobile, Blogging, Web2, education.

INTRODUCTION

A junior at the university, Eric wakes up and peers at his PC to see how many instant messages (IMs) arrived while he slept. Several attempts to reach him are visible on the screen, along with various postings to the blog he's been following. After a quick trip to the shower, he pulls up an eclectic mix of news, weather, and sports on the home page he customized using Yahoo. He then logs on to his campus account. A reminder pops up indicating that there will be a sociology quiz today; another reminder lets him know that a lab report needs to be emailed to his chemistry professor by midnight. After a few quick IMs with friends he pulls up a wiki to review progress a teammate has made on a project they're doing for their computer science class. He downloads yesterday's chemistry lecture to his laptop; he'll review it while he sits with a group of students in the student union working on other projects. After classes are over he has to go to the library because he can't find an online resource he needs for a project. He rarely goes to the library to check out books; usually he uses Google or Wikipedia. Late that night as he's working on his term paper, he switches back and forth between the paper and the Internet-based multiplayer game he's trying to win (Oblinger & Oblinger, 2005).

The above snapshot of today's learners gives us an idea of some of their characteristics:

- Technically literate
- Multitasking
- Collaborative
- Connected

To engage these learners a lot of thought must be given as to how their preferred means of communicating can be integrated into the teaching and learning environment. Mobile devices are inherently social, enabling rich social interaction, and the potential for enhancing group work and communication within educational settings. Today's learners are constantly connected to their social networks via their wireless mobile devices. Their preferred method of communication is text messaging (65% (Cameron, 2006)), followed by instant messaging (New Zealand Herald, 2006).

Pedagogy and today's learners

Mobile devices coupled with wireless networks have been described as 'disruptive technologies', and so have the Web2 social software tools that have developed (Blogs, Wikis, podcasting, vodcasting, online photo blogging etc…) (Alexander, 2004; Fielder, 2004; Lamb, 2004). Their disruptive nature forces a rethink of pedagogical strategies and relationships in education.

A pedagogical framework for implementing social software tools via wireless mobile devices can be developed by drawing on concepts from: constructivism (Bruner, 1966; Piaget, 1973), social constructivism (Vygotsky, 1978), communities of practice (Wenger, 2005), a conversational model of learning (Laurillard, 2001), and the social construction of technology (Bijker, 1995).

Thus a mobile (m-learning) pedagogical model will focus upon enhancing communication, collaboration, and will be student-centred.

Web2

'Social Software' (interactive collaborative software) is one of the key features of what has been termed 'Web2' (O'Reilly, 2005). Examples of current and emerging social software tools include Blogs, Wikis, RSS, instant messaging, podcasting, social book marking, etc… (Farmer, 2004; Glogoff, 2005; Kaplan-Leiserson, 2004). The key characteristics of social software fit well with the pedagogies described above, enabling a natural and relatively simple approach to creating collaborative learning communities.

Web2 is about:

- Moving beyond CONTENT

- Ease of use

- Interactivity

- Collaboration & sharing

- Customisation

- Personal Publishing

To illustrate the end-user emphasis of Web2, Time magazine named 'You' as person of the year for 2006 (Grossman, 2006). The educational implications of Web2 social software is the source of recent interest (Alexander, 2006; Alexander *et al.*, 2006; Anderson, 2007; Becta, 2006, 2007; Bryant, 2006; New Media Consortium, 2007).

Wireless Mobile Devices coupled with open-source Social Software tools potentially provide the basis for enhancing teaching and learning in virtually any discipline, providing an environment that stimulates reflection, critique, collaboration, and user generated content – i.e. a social constructivist environment.

Blogs
A Blog is a reverse chronological online journal, the newest postings appear at the top of the Blog while older postings are archived. Only the owner of the blog, and those given group membership by the owner can make Blog postings. However, visitors can add comments to Blog postings, and automatically check for new postings via an RSS/Atom newsreader. A Blog is a much more personal space than a typical LMS asynchronous discussion forum. Blog hosting software usually provides customisable templates, and add-on widgets for embedding multimedia files. Additionally a Blog is usually accessible via the Internet without requiring institutional passwords, and remains the property of the student/owner after the completion of their course. Bloggers therefore have a potential worldwide audience and can form international networks with like-minded people. Some employers are Googling potential employees to check their suitability. These aspects add incentive to students to develop and maintain a quality Blog.

There are a variety of free online Blog hosts, the most popular being http://www.blogger.com. Other examples include:
- http://edublogs.org
- http://wordpress.com
- http://my.opera.com/community/
- http://www.vox.com

Blog posts can be made via a web browser, a dedicated blogging application, via email, SMS, or via plug in extensions to web browsers like Firefox or Flock, or even MS Word. Readers interested in regularly following a Blog can subscribe to it via its RSS feed.

There has been a lot of interest in the educational applications of Blogs (Educause, 2005; Educause Learning Initiative, 2005; Farmer & Bartlett-Bragg, 2005; Luca & McLoughlin, 2005; Trafford, 2005). In an educational context, blogging can be utilised as an online reflective journal. The use of reflective journals in education is well established (Bain *et al.*, 1999). Similar strategies for assessing and moderating the familiar online discussion forums utilised in most Learning Management Systems (LMS's) can be used for Blogs.

An assessment rubric may cover: the expected number and regularity of Blog posts, quality of reflections, references to external sources, the number of comments, use of multimedia, alignment with the course or project content/context etc... Student Blogs linked via RSS feeds and using a Tutor Blog to notify students of important details using RSS can form the basis for a rich online collaborative community (Farmer, 2004). Blogging enhances the following skills (Panday, 2007):
- Sharing — thoughts, concepts, experiences, knowledge
- Analyzing
- Reflecting — Critiquing, Writing, Questioning, Reacting
- Reading
- Communication
- Record keeping — thoughts, concepts, and experiences

- Collaboration — with peers, people (experts, students) around the world

Variations on blogging include image and video blogging. Currently two of the most popular examples are http://www.flickr.com (Image blogging) and http://www.youtube.com (Video blogging). Emerging Mobile multimedia blogging sites include: http://www.splashblog.com and http://www.mojungle.com. By embedding or linking to a variety of online media formats (e.g. YouTube videos, Flickr images, interactive slideshows, Word and PDF documents via Google Docs or Zoho etc…) students can effectively create customized eportfolios (electronic online portfolios). These blogs/eportfolios can be an important aspect of students developing critical and reflective life-long learning skills. The ability to include visual and audio material into the blogs adds a whole new creative dimension for students. The possibilities in the educational use of blogs are limited only by the Tutor's imagination. Language students can use Blogs as a means to practice reading and writing skills. Design students can use blogs to record their design process and steps, while generating feedback from other students world-wide. Blogs can be used as an interface between student projects and industry, with industry representatives able to read and comment on the progress of student projects. Tutors can provide more timely feedback to students on their progress, unlike traditional paper-based reflective journals that are only marked at the end of the process.

RSS
Rich Site Summary, or Real Simple Syndication, RSS provides a way of subscribing to content via news reading software (e.g. http://www.newsgator.com/). RSS can be used as an enabling/delivery mechanism common to most social software tools (Kaplan-Leiserson, 2004; Wenger *et al.*, 2005). RSS is a real time saver. Instead of logging onto favourite Websites one at a time, a newsreader application can be used to automatically download the headings of new posts, and then a decision made to visit the site for more information or not.

RSS is a great companion to Blogs - you can subscribe to all the Blogs in your classes in one simple window and keep track of your students' progress.
Most news type websites now have RSS feeds. There will be an orange 'XML' or 'RSS' or 'FEED' symbol on the site, clicking on the symbol will reveal the RSS feed address and insert it into your preferred RSS news reading software.

Online News Aggregators
Subscribing to and reading RSS feeds online can be accomplished using several free online news aggregator systems:
Newsgator (http://www.newsgator.com) allows you to subscribe to your favourite RSS feeds and read them on any Internet connected computer with a web browser. It also supports synchronization with dedicated RSS news reading software on Mac (NetNewsWire) and PC (FeedDemon), and the ability to synchronize subscriptions between multiple registered computers with one Newsgator account.
Bloglines (http://www.bloglines.com) is very similar to Newsgator, but also has free support for mobile devices. This is a pay - 'premium' option with Newsgator.
Google Reader (http://www.google.com/reader) is the challenger to the online RSS reading throne. Google Reader is part of a suite of free online Google tools that provide simple mobile interfaces, making it a good option. These include: GMail, Google Calendars, Search, Maps, Picasaweb etc…

MOBILE BLOGGING

Why Mobile?
The convergence of ubiquitous broadband, portable devices, and tiny computers has changed our concept of what a phone is meant to be. A pocket-sized connection to the digital world, the mobile phone keeps us in touch with our families, friends, and colleagues by more than just voice. Our phones are address books, file storage devices, cameras, video recorders, wayfinders, and hand-held portals to the Internet—and they don't stop there. The ubiquity of mobile phones, combined with their many capabilities, makes them an ideal platform for educational content and activities. We are only just beginning to take advantage of the possibilities they will offer. (New Media Consortium, 2007)

Today's mobile phones are powerful computers. The catch phrase of Nokia's current add campaign for its N-Series smart-phones is: "It's what computers have become" (Nokia, 2007a). Mobile phone ownership in New Zealand has almost reached 100 per cent (81.1% 2004 (Cameron, 2006)). Its rise to ubiquity is described as a

…stealthy but rapid shift from a telephony device towards a portable, personal media hub that enables an increasing range of personalised and customised communication, entertainment, relationship management and service functions. Its reach is pervasively global and trans-cultural, possibly more so than any other media form including the internet and world wide web (Cameron, 2006).

The largest growth area regarding Internet usage is mobile access. "'Mobile, mobile, mobile,' were the words of Google chief executive Eric Schmidt recently when asked what technologies are most intriguing to the computer web search leader" (Wakabayashi & Auchard, 2007). Marc Prensky remarks: "What can you learn from a cell phone? Almost anything!" (Prensky, 2005).

Key Issues
Here we discuss some of the practical issues that need to be considered when designing or implementing mobile blogging trials in an educational setting. These have been identified from the several mobile trials that the author has instigated. Considering the impact of these issues will save time and stress later.

Technical support and mobile configuration
Mobile carriers are attempting to make Internet configuration of mobiles relatively simple. In New Zealand, all Telecom mobiles come pre-configured for the internet, while Vodafone provide an SMS auto configuration service (Vodafone NZ, 2007c). Parallel imported phones can usually be set-up from SMS auto configuration forms found on the manufacturers local website (Motorola, 2007; Nokia, 2007b; Sony Ericsson, 2007).

As every different mobile manufacturers web browser is different, to keep the user experience as similar as possible, use the Opera Mini web browser, which can be downloaded to almost any internet and Java capable mobile phone by typing the URL http://operamini.com into the phones built-in WAP or web browser.

Fast mobile data access is not required for blog posting and RSS reading, as these are basically text based. However, 3G data access is required for multimedia blogging (picture, audio or video uploading). 3G coverage maps are usually available from the local telecommunication carriers, e.g. Telecom (Telecom New Zealand, 2007c) and Vodafone (Vodafone NZ, 2005).

Data costs
For mobile email and Internet access a data account is required. For basic mobile blogging and RSS reading a low data plan (10-20MB/month) will probably suffice. For multimedia blogging a 'broadband' mobile data plan will be required (Telecom New Zealand, 2007a; Vodafone NZ, 2007a). If you do not have a data plan, you will be charged at the 'casual data' rate:
- Vodafone NZ (Vodafone NZ, 2007b) = 1c per Kb = $10000/GB
- Telecom NZ (Telecom New Zealand, 2007b) = 5c per Kb = $50000/GB

Variety of handsets
Providing support for the wide variety of available mobile phones can be daunting. For example there are at least nineteen mobile manufacturers supplying cell phones to the New Zealand market. However, as there are only two mobile carriers who promote a small set of handsets during various specials, the actual variety is relatively small compared to the worldwide market. Thirteen handsets, from five manufacturers currently hold seventy one percent of the New Zealand market. Mobile users update their mobile phone on average every eighteen months. However, teenagers tend to update much more often, and generally have two mobiles to catch both of the Telecom and Vodafone specials.

Manufacturer	Market Share
Motorola	33.97%
Nokia	23.6%

Sharp	21.69%
Sony-Ericsson	9.31%
Samsung	2.2%

Table 1. Manufacturer market share in Oceania – New Zealand, March 2007 (Mobref, 2007).

Manufacturer	Market Share
Nokia	42.79%
Sony-Ericsson	16.72%
Motorola	12.48%
Samsung	8.78%
LG	1.53%

Table 2. Manufacturer market share worldwide, March 2007 (Mobref, 2007).

Integration into teaching and learning

One of the biggest challenges is the changing role of the teacher. This includes the need to become techno-savvy in order to model the educational use of the technology, particularly if the teacher is also the technology steward (Wenger et al., 2005) for the class/community. Support structures can be developed utilizing the concept of communities of practice. A community of practice can be based around the course/class – incorporating the teacher, technical support (if outside), and students. A community of practice that provides teacher support can also be created from like-minded teachers. The members need not be limited to your local institution – use the tools: create a support blog, subscribe to relevant blogs, use instant messaging to communicate with peers worldwide etc…

Small screen size

The small screen size of mobiles makes them an inherently personal device. In a classroom setting, demonstrating the set-up and use of mobile blogging requires some creative pre-planning. This may mean either using remote screen controlling software on a PC connected to a video projector, or creating slides/movies using screen-grabbing software on the mobile and transferring the screenshots to a PC via USB, or Bluetooth. Another alternative is to use the SDK java application development kits that most manufacturers provide for free, but then you are limited to demoing Java applications only. Videos taken directly of mobile use tend to be of poor quality for viewing detail, but give an idea of their usage. Bluetooth mobiles can stream pictures and audio via Bluetooth multimedia converters, but do not mirror the mobiles on screen displays. Finally, the latest Nokia handsets (N95 and N93) supply direct video out ports for large screen viewing – at the expense of battery usage.

Overview

Blog options for mobile include: SMS (Short Message Service, i.e. text messaging), MMS (Multimedia Messaging Service), email, mobile formatted Web interfaces, Java clients, and specific mobile OS application clients for smart-phones (Windows Mobile, Palm OS, Symbian, Linux). Most mobile blogging options initially require the Blog host to be set-up using a PC before being accessed via the mobile, although there are some exceptions.

SMS Blogging

The simplest mobile blogging solution is to use text messaging to post to a Blog. The main limitation is the 160-character limit of text messages, so SMS Blog posts will always be short. Most mobile carriers provide an SMS Blog service for their customers, however their blog software is usually not as configurable as the more popular mainstream Blog hosts. To SMS post to these 'mainstream' blog hosts requires an intermediary service. One such free service is http://letmeparty.com. This is simple to set-up, and works with the most popular Blog hosts.

A PC with Firefox (letmeparty.com does not support Internet Explorer Jscript) can be used to create a free registration at letmeparty.com. At the site a mobile phone number can be registered (in international format: i.e. +6421xxxxxx for Vodafone NZ), the Blog host type, address, username and password entered, and finally an SMS sent to +13128047068. Letmeparty.com forwards the SMS to your Blog as a post.

Email and MMS Blogging
Older Blog hosts supported mobile blogging via email and MMS, although almost all Blog hosts offer this as a mobile blogging option. This requires the set-up of the Blog host on a PC, followed by obtaining the 'secret' email address to access your Blog (found in your Blog settings). Your mobile must be configured for sending email via your mobile carrier. Then you can put your Blog email address into your mobile address book, and simply send an email to this address to Blog. The email subject becomes the post title, while the main text of the email becomes the text of your Blog post. Attaching pictures, audio, or video to your Blog email address will usually allow uploading of this content to your Blog host. The advantages of email blogging on mobile phones include: being able to compose a blog message of any length 'off-line', utilizing the built-in text tools of the mobile email client (html text formatting and spell-checking – if supported), and being able to save copies of blog posts on your mobile phone (although most phones do not have large memories). The main disadvantage is the email configuration required.

MMS messages are simpler to compose than email and most phones come with MMS pre-configured. Also MMS does not require a data account (Mobile providers usually charge a set amount per MMS, similar to TXT messages). An MMS can contain text (greater than 160 characters), images, video, and audio files. Sending a picture via MMS to a blog host's email upload address will achieve similar results to an email with an attached picture. However, depending on how the mobile service provider interprets MMS to email messages, additional text included in the MMS message may not end up as the main blog post.

Of the currently popular free blog hosts, Wordpress is the odd one out, not supporting email uploads as blog posts. However, Flickr.com includes an email to blog forwarding feature that allows an email or MMS message to be forwarded to Wordpress, or virtually any other blog host.

Web2 Mobile Blogging
A revolution has been underway with the convergence between Web2 social software and mobile devices. These mobile Web2 services enable constructivist collaborative environments with very little technical overhead required by the lecturer or students.

The recent release of the Opera mobile and mini web browser (Opera Software, 2006) for almost every mobile phone and PDA has opened the door for viewing many standard Web sites and Web2 services on mobile devices without any translation. However, the best mobile experience comes from Blog hosts that have dedicated mobile friendly versions for viewing and posting, e.g.
- Wordpress http://m.wordpress.com
- Flickr http://m.flickr.com
- MyOpera http://my.opera.com
- SplashBlog http://www.splashblog.com
- MoBlogUK http://moblog.co.uk

The Opera mini web browser also supports most camera phones for picture blogging directly to http://my.opera.com, and includes a built-in RSS reader for a limited number of on device subscriptions. There is an online demo of the Opera mini web browser at http://www.operamini.com/demo.

Web2 Mobile RSS
Most online news reading sites now have mobile access, though not all provide this facility for free. Good examples are:

- Google Reader http://www.google.com/reader/m/view/
- Bloglines http://www.bloglines.com/mobile/
- LiteFeeds http://litefeeds.com/w
-

Java Clients
Java clients are small applications that can be downloaded via a PC and installed onto your mobile (via USB or Bluetooth), or installed directly onto your mobile 'over the air' (OTA) by putting a download URL into your mobile's built-in web or WAP browser. The Java application lives on your mobile, and requires configuring with the address, username and password for your blog and RSS host. The mobile device

must be configured with appropriate Internet access settings for your mobile carrier, and a data account is recommended. These Java clients do not require specific mobile versions of blog hosts, but provide a simple mobile interface to most standard blog hosts. While most modern mobiles support Java applications, there are differences between manufacturers and even models that make wide compatibility difficult. The following Java client examples have wide compatibility:

Example Java Blogging Clients
- Kablog http://www.kablog.org
- Blogplanet http://www.blogplanet.net
- Opera mini http://www.operamini.com
- Shozu http://www.shozu.com
- BluePulse http://www.bluepulse.com
-
Example Java RSS Clients
- LiteFeeds http://litefeeds.com/m
- Opera mini http://www.operamini.com
- NewsgatorGo http://www.newsgator.com
- Nokia Widsets http://www.widsets.com
- Bluepulse http://www.bluepulse.com

For more information visit the author's Wiki page on mobile learning (Cochrane, 2006).

CONCLUSION

The educational benefits of social software, in particular blogging, have been discussed. The alignment with social constructivist pedagogy and new learner preferences provides the potential for the development of collaborative learning communities, enhancing student-student and student-tutor communication and interaction. Mobile blogging coupled with social software tools potentially provide the basis for enhancing teaching and learning in virtually any discipline, providing an environment that stimulates reflection, critique, collaboration, and user generated content (i.e. a social constructivist environment). Issues and options around mobile blogging have been discussed, providing a starting guide for educators who want to engage with mobile blogging.

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MOVING MOBILE MAINSTREAM: USING COMMUNITIES OF PRACTICE TO DEVELOP EDUCATIONAL TECHNOLOGY LITERACY IN TERTIARY ACADEMICS

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ABSTRACT

A case study of how a communities of practice (COP) model (Wenger et al., 2002) transformed a group of IT phobic tertiary academics (Cochrane, 2006a) into educational technology evangelists (Cochrane, 2006b). How the 'technology steward' (Wenger et al., 2005) guided the group in an investigation of the educational potential of various social software (web2) and elearning and mobile technologies (Cochrane et al., 2006b). And the culmination of the COP in a two hour workshop presentation (Cochrane et al., 2006a) by the group on their journey and outcomes (Cochrane et al., 2006c). Finally, how the model is now being used on an institution-wide basis for developing educational technology literacy in tertiary academics and establishing collaborative mobile learning projects. Thus moving mobile projects beyond the domain of the techno-geek academic and within reach of 'ordinary' academic teaching staff.

Author Keywords
Communities of Practice, Mobile, Social Software, Web2, Technology Steward.

INTRODUCTION
The Problem

1. Disconnect between technology skills of today's learners and today's teachers.

2. How to maximise the learning environment for academic staff.

3. How to promote mobile learning throughout the institution.

Today's learners naturally engage with technology as an everyday part of their lives (Prensky, 2005). However, when attempting to use technology to engage today's learners, there is often a disconnect between the techno-savvy of the learners and the lecturers. A recent article in the New Zealand TUANZ Topics magazine asks: "Are web2 communication tools such as blogs, wikis, webcasts and podcasts now an essential part of the teacher's toolkit?" (The article is written from a secondary school perspective). They conclude:

> You and I are the last generation that has the prerogative of deciding whether or not we're going to embrace technology. But the kids we are teaching now, the ones that are under my watch in the classroom, they aren't given that same prerogative. If they don't master these skills, I'm actually dooming them to a lower level of opportunity...

> The thing we need to understand about the type of learners coming to us today is that not only do they have different tools, but they actually process differently.

> Most kids are walking around with one or two cellphones in their pocket, using them to text their friends, surf the Web, take photos, and post to their blogs. And yet as soon as they get to school they're told to turn the cellphones off.

> If we'd just let students work to their strengths, instead of their weaknesses, we'll start to celebrate what they can do, and what they come to the classroom with - and that is a propensity toward technology (Putt, 2007).

In comparison, many of today's lecturers may be unfamiliar or uncomfortable with the use of the tools described above (Blogs, wiki's, RSS, instant messaging etc…). Before lecturers can implement mobile learning they require understanding and experience of a range of foundational learning technologies. Most mobile learning trials involve only a small number of lecturers, who are already techno-savvy enough to be confident in moving to mobile learning. To move mobile learning into the mainstream of an institution requires a strategy for up-skilling academics in integrating technology into their pedagogies.
The Solution

Development of peer group support guided by a teaching and learning professional, i.e. a Community Of Practice, investigating the use of web2 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.

COMMUNITIES OF PRACTICE
'Communities of Practice' (COP) is a relatively new approach to learning. The concepts were developed by Lave and Wenger, while studying the apprenticeship model of learning (Lave & Wenger, 1991), "Communities of practice are formed by people who engage in a process of collective learning in a shared domain of human endeavor" (Wenger, 2005).

Social Constructivism
Social constructivism forms the underlying basis for learning theories such as 'Communities of Practice'. Constructivism is based on the work of Piaget (1973), Dewey (1916) and Bruner (1966). According to these theorists, knowledge is constructed from our own experiences, and facilitated by teachers. The learner learns by being involved in the learning process, constructing new concepts from simple ideas and previous experiences. Social Constructivism is an extension of constructivism, and is attributed to Vygotsky (1978), according to whom the social context is very important in constructing knowledge. Vygotsky argued that learning is a collaborative process of students actively constructing their knowledge through interaction with their peers and teachers while engaging with the learning tasks. According to Vygotsky the role of the teacher is to create and maintain the Zones of Proximal Development (Head & Dakers, 2005) – an environment that will help move the learner from their current understanding to a potential deeper level.

Characteristics of Communities of Practice
The main differences of Communities of Practice to traditional educational environments are an emphasis on inventiveness, evolution of ideas and direction of the community, and lack of hierarchy, as all the members in a Community of Practice interact as peers.

The three characteristics of Communities of Practice
- The Domain – the shared interest.
- The Community – some form of regular group relationship.
- The Practice – the development of a shared repertoire of resources, involving time and sustained interaction.
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Legitimate Peripheral Participation
Lave and Wenger assert that passive community members learn from the active members of the community, and are gradually brought into an active role in the community.

Attwell (2006) draws a comparison between the concept of legitimate peripheral participation and Vygotsky's zone of proximal development.

> Bridging the zone of proximal development construct with legitimate peripheral participation construct may be accomplished if one thinks of a zone in which the expert or mentor takes the learner from the peripheral status of knowing to a deeper status… the expert scaffolds the environment to the extent in which the learner is engaged with the discourse and participants within the zone and is drawn from a peripheral status to a more engaged status. The peripheral learner interacts with the mentor, expert learners and peers within the zone. More able learners (peers) or the mentor will work with the less able learner potentially allowing for socially constructed knowledge (Attwell, 2006).

Social Software and Communities of Practice
Wenger (Wenger et al., 2005) discusses the contribution that technologies can make to communities of practice, in particular Web2, social software tools.

He describes two tensions that communities must live with but can mitigate using technology via a cycle of inventiveness:

1. Community implies an experience of togetherness that extends through space and time.
2. The relationship between communities and individuals.

Social software tools make a natural companion to Communities of Practice. 'Social Software' (interactive collaborative software) is one of the key features of what has been termed 'Web2' (O'Reilly, 2005). Examples of current and emerging social software tools include blogs, wikis, RSS, instant messaging, podcasting, social book marking, etc… (Farmer, 2004; Glogoff, 2005; Kaplan-Leiserson, 2004). The key characteristics of social software fit well with the pedagogies described above, enabling a natural and relatively simple approach to creating collaborative learning communities. Web2 is about moving beyond content delivery to an interactive collaborative environment with an emphasis upon sharing, ease of use, customization and personal publishing. Thus in the educational setting, providing opportunities for students to be involved in the learning process, to create their own unique collaborative environments that can be shared globally. This can involve the collation of a variety of media centric web based tools/sites that can be aggregated via RSS to form virtual eportfolios.

> This emerging class of flexible, boundary-spanning tools has been called social software by its proponents. The label points to the user's ownership of their software-mediated experience and to the ways that the software bridges between the individual and the group. Easy publication and easy group formation, driven by individuals, are key phrases in this new frame for online collaborative technologies (Wenger et al., 2005).

The Technology Steward

Communities of Practice can be enhanced with the use of appropriate communications technologies when under the guidance of a Technology Steward. The Technology Steward (Wenger *et al*., 2005) is a member of the community with a grasp of how and what technologies can enhance the community. They act as a guide to the rest of the community as the community learns to utilize and benefit from technology. The technology steward in these case studies is either Thom Cochrane or Giedre Kligyte from the Centre for Teaching and Learning Innovation at Unitec. Our experience indicates the crucial role of the technology steward in guiding the Community of Practice in their investigation of the pedagogical usefulness of technology. When applying a Community of Practice approach to a course/class environment, the technology steward role would most beneficially be that of the teacher. One of the biggest challenges in taking this approach is the changing role of the teacher. This includes the need to become techno-savvy in order to model the educational use of the technology. However when the teacher is not up to speed with the technology utilized by the community, or does not engage with it, then the technology steward role defaults to someone else within the community or class. The problem then is the potential for the community or class to go off on a tangent from lack of pedagogical guidance. The technology steward thus forms a pivotal role in the successful integration of mobile learning. When first implementing the ideas investigated during the COP a partnership with an external (to the class) Technology Steward is useful in building the academics technology steward skills.

CASE STUDY1: DUMMIES2DELIGHT

Beginnings

The Community of Practice (COP) was born out of discussions between the founding group member and the author (Academic Advisor – elearning & Learning Technologies). The COP was devised as a way of bridging the gap between today's learners and teachers. Admitting that there is a gap that needs bridging is a significant first step. The following is a selection of comments made by the members of the COP regarding their initial comfort levels with integrating technology into their teaching (Cochrane, 2006a):

Lecturer 1: "When people talk IT stuff, for me its like a foreign language – I don't even know if IT is the label I should be using".

Lecturer2: "In my Diploma programme we need more flexibility, we have a lot of students who want to come in at odd hours and are working, and this technology stuff should offer my students a lot. However I'm scared of it. I don't want to just dive in. In the past I've always hung back because I always think there's going to be bugs in the system".

Lecturer3: "I guess I feel a burning desire to learn about this stuff, but I've never created the space to do it, and I suppose that's an excuse".

Lecturer4: "I just feel totally out of touch with the technology, particularly when I see what my kids can do, and I haven't really had any motivation to go about updating myself. But I guess for me one of the issues is whether the technology overshadows good pedagogy, and I want to be absolutely sure that technology enhances pedagogy rather than gets in the way of it".

The Journey
The technology steward chose a range of communication, collaboration, and social software tools for the group to investigate. The choices were made on the basis of a social constructivist pedagogy, constituting a selection of indicative technologies that would work well together and sites that had good policies on content appropriate for an educational setting. The COP was comprised of heads of schools within the vocational studies department of Unitec. From an initial six respondents five started the COP with four members completing the COP (one member withdrew due to health issues). The first meeting took place over breakfast in one of the campus café's, where the participants voiced their initial hesitations with using technology in teaching. This then became the baseline from which the group measured its progress. Weekly two-hour workshops were held in the Centre for Teaching and Learning Innovation's computer classroom, and participants were expected to interact and practice with each technology during the following week using their work and home computers. Regular revision sessions were also scheduled using a group wiki page (Cochrane et al., 2006b).

Notes and discussion forums were set up online for each weekly meeting of the COP using Blackboard – the LMS for the institution. Each participant was encouraged to create and maintain a student homepage in the Blackboard course updating it with links to their blog, flickr site, etc as they created them. Although Blackboard has been the official LMS for the institution since 1998, none of the group participants had used it beyond the very basics. However, Blackboard was the least threatening environment to expose the group to as they entered the world of cyberspace. The use of Blackboard as a learning tool was thus modeled by the technology steward as it was used to link and discuss the various social software tools. Their Blackboard homepage became a contact hub for the group participants until they became confident with RSS and subscribing to each others' social software sites. Topics included in the Dummies2Delight investigation are outlined below in Table 1:

Topic	Examples
Interactive use of LMS's	Blackboard and Moodle
Social Software in Tertiary education	An overview of current technologies
Blogging	www.blogger.com
Image Blogging	www.flickr.com, picasaweb.google.com
Instant Messaging	AIM, MSN
RSS and aggregators	www.newsgator.com
Wikis	Mediawiki, www.wikispaces.com
Podcasting	iTunes, www.podomatic.com
ePortfolios	ELGG
Digital Video	YouTube, BlipTV, iMovie
Mobile Computing	SMS Blogging via www.letmeparty.com

Table 1. Topics covered in the Dummies2Delight COP.

After gaining some confidence with the selection of social software tools that were investigated by the group, the group members began to document their journey from technological illiteracy to technological delight using a group wiki (Cochrane et al., 2006c). This became a focal point for the group to reflect on how far they had come and how to integrate the new ideas into their teaching practice. Eventually group members also began to feedback examples of how they were implementing some of the technologies with their own courses and students.

Nurture: Communication and Social Software

One of the key goals of the group was to create a collaborative environment utilising collaboration and communication technologies. The use of instant messaging became a cornucopian revelation for the group as a means of peer support when they were dispersed across the institution and at home.

> The beauty of IM is the immediacy of it. You talk in real time and so the conversation flows without having to wait for emails to go back and forward and it also allows for collective conversations. I can see that it can be addictive if you don't watch out (Cochrane et al., 2006b).

Subscribing and commenting on each other's blogs and photoblogs also nurtured the group.

> I think that being introduced to RSS stuff after having done Blackboard, Blogs and Flickr is a good idea because you start to get the feeling that it's all getting too vast, and then along comes RSS to make it all manageable (Cochrane et al., 2006b).

The weekly face-to-face workshops were also a source of group identity building. Finally, having a common concrete goal for the group kept them focused and ensuring that everyone was keeping pace with each other as they learnt.

> It is very easy to let the words roll off your tongue now. At the BoS today, I listened to Ray talk about Blogs, Flickr, RSS, Newsgator, Wikis etc as if they were words and concepts we had known forever. The words are easy. Some of the concepts are easy. Some are still complex and, while I can achieve some things independently, I am still not 100% clear about working my way painlessly and seamlessly around these. I can only assume that, like other technologies I have mastered in the past, it will become second nature with use. There is no doubt we've progressed enormously. But in helping Malcolm with some updates yesterday, I realised that I'm only just remembering some of the concepts. It is the use it or lose it concept (Cochrane et al., 2006c).

The Goal

A timeframe and goal were used to give the COP a focus and an initial lifespan. The goal was to present a workshop on the use of social software tools in education at the institution's Teaching and Learning Symposium in six months time. These were brainstormed between the group founder and the technology steward before the establishment of the COP, but were presented to the group as a possible goal for negotiation by the group at their first meeting. The group agreed with the proposed goal and timeframe, while also feeling included in the decision making process.

This goal provided the group with an opportunity to formalise their reflections, work together on a specific project, and produce a research output. By running this workshop, the group effectively became educational technology 'evangelists' and made regular progress reports at each board of studies meeting, creating quite a buzz and a lot of anticipation regarding the workshop presentation. The workshop consisted of demonstrations of instant messaging, the use of wiki's for audience participation (Cochrane et al., 2006a), and presentations by each group member on each of the social software tools investigated during the COP (Cochrane, 2006b). From the technology steward's point of view it was amazing to see the transformation of the group.

INSTITUTION-WIDE MODEL

Model
After the success of the first Dummies2Delight Community of Practice the Centre for Teaching and Learning Innovation (CTLI) decided to put more resources into developing this approach to academic staff development model as an alternative to blanket staff development workshops. The COP approach enables the COP members to define the scope and the aims of the learning explorations and enables CTLI staff to offer more targeted support. The prolonged engagement of 7 to 16 weeks ensures that the technologies are practiced over a period of time, as opposed to the one off encounters usually experienced in CTLI workshops.

Interest was developed throughout the institution by the Dummies2Delight workshop/presentation at the annual Teaching and Learning Symposium, giving the concept a high profile. As resources are limited, the current approach to creating Communities of Practice investigating educational technology is on an invitation basis. Invitations to form COPs are initiated with schools that either express an interest or appear to have the potential to benefit from the approach. The model is currently in a viral mode of spreading. It is envisioned that eventually graduating COP members will become technology stewards for further COPs to be formed within their school.

An invitation letter briefly outlining the concept, commitment required, topics covered, and links to examples is sent to interested participants. Following this, a first group meeting is scheduled, usually involving coffee and food as an incentive. At the first group meeting a goal, timeframe, workshop style/modes and weekly time are brainstormed, along with an indication of what the participants' initial confidence with educational technology is.

Structure
Four to six group members per COP plus the technology steward meet weekly for a two-hour workshop to explore the educational potential of different technologies. After the use of elearning tools are established much of the interaction can be undertaken 'virtually' and flexibly if required, however the social element of meeting together has been found to be important in 'nurturing' the COP. The workshops are facilitated by either Thomas Cochrane or Giedre Kligyte, and can be held either in the CTLI multimedia lab, or elsewhere on campus (including the campus café Kreem with wireless laptops). Each different COP culminates in a specific project goal (e.g. a presentation at the Teaching & Learning Symposium, a presentation at a conference, a presentation to other academics in their department, incorporation of some of the technologies investigated into their own courses, a specific mobile learning project etc…). Topics covered include (but are not limited to) those outlined above in Table 1.
Topics, the goal, the LMS, and the COP workshop format are all open for negotiation with each COP group, allowing a customized experience relevant to each unique group, and allowing for the rapid change in the multitude of social software options available.

Key Issues
Some of the practical requirements to successfully support the formation and collaboration required for the COPs include:
- Participants require basic computing and Internet usage skills.
- Participants require access to their own computer and Internet connection.
- Participants require a mobile phone and data account.
-
EXAMPLE COPS

Diploma Landscape Design
One of the Dummies2Delight COP 'graduands' partnered with CTLI to integrate educational technologies to enhance a student group project. The project focused on using blogs and online photo albums accessed via both computers and WiFi Palm PDAs to document and reflect upon the design process for landscape designs for the Ellerslie Flower Show (A national Flower Show and landscape design event). In 2006 the students involved in the project received two gold and one bronze awards for their designs. The success of the project has led to on-going collaboration between the Diploma Landscape Design and CTLI. Effectively a COP is created involving the lecturer, the technology steward, and the students. The 2007 project is focusing upon using mobile phones for blogging to enable wider connectivity and

more immediate posts. The success of the project is also developing interest from other lecturers in the department, with a COP with more of the teaching staff scheduled for semester two of 2007, with the aim of implementing mobile learning projects with a variety of student classes in 2008.

Product and Object Design
A pre COP collaborative project between CTLI and the Bachelor of Product Design identified several issues that could be aided by a COP with the teaching staff. The project involved students forming virtual design companies and using blogs and WiFi enabled PDAs to document their design process. Some of the issues identified helped establish the Dummies2Delight COP model. Issues identified included:

- Not enough technical support for staff and students (This identified the need for a Technology Steward and regular support sessions).
- Lack of lecturer engagement with or modeling of the pedagogical use of the technology.
- Limited connectivity for wireless PDAs (The campusWiFi network has since been extended significantly).
- Student preferences for their own mobile devices rather than loaned units.

A COP with the Design teaching staff has started during semester one 2007 with the goal of developing a more successful student mobile blogging project in semester one 2008. Already the lecturers' engagement with blogging and their understanding of the pedagogical potential have increased dramatically.

DISCUSSION
Successes
The Dummies2Delight COP created a core group of senior management evangelists in the institution that had previously not existed. This in turn led to an increased interest across the institution from teaching staff, many of whom attended the Dummies2Delight Teaching and Learning Symposium presentation. The COP model has led to a better use of the limited professional development resources of CTLI. The COP groups have resulted in a range of collaborative projects between CTLI, Lecturers, and Students. Finally, having a negotiated, concrete goal for each COP has facilitated measurable outcomes that are often unseen by the usual generic staff development workshop approach previously taken by CTLI.

One of the most exciting results is that the COP model develops strong relationships between the technology steward and teaching staff that can then lead to ongoing collaborative projects. These collaborative projects are then used to show-case innovative ideas as a way of getting new people on-board by contextualizing the integration of technology into teaching and learning with concrete local examples.

Hurdles
There are several challenges that have been identified in implementing the COP model. Some of the 'second-generation' COPs have not been as successful as the original Dummies2Delight group, leading to reflection on some of the assumptions made. Establishing a peer relationship between the technology steward and the rest of the COP participants is crucial to move the group from a traditional 'workshop' model to a COP model. Some participants have assumed the role of the technology steward to be that of a teacher for the group, and consequently there has been little peer support and collaboration in such groups. Establishing the COPs via an invitation from the technology steward to potential members has also required re-thinking. In a couple of cases we have unwittingly invited disparate groups of people to form a COP. A better approach has been found to be to invite a key staff member in the school to nominate/invite the other members of the group that they wish to work and collaborate with in a COP.
Other issues include managing concrete goals/outcomes to keep the members of the COP motivated. Group size is important to create enough interaction without creating too many peripheral members. The participants' require access to the technology being investigated, which requires a partnership with the institutions IT department. Installation and updating of software on lecturers computers and student labs is often restricted by the institution's IT department. Additionally, firewall and packet-shaping restrictions may make media sites (e.g. YouTube) and synchronous technologies such as Skype unusable. Finally, limited resources, including the number of available technology stewards currently limits the number of manageable COPs, making the move beyond viral implementation slow.
Key Issues

Some of the key issues in the success of a COP that have been identified include the importance of:
- The Technology Steward to guide the group
- Developing quality partnerships between the Technology Steward and teaching staff
- Dedication and peer support of the group
- Communication
- Choosing achievable goals
- Team building/nurturing
- Involving senior management
- Reflection
- Recognition of the uniqueness of each COP group

CONCLUSIONS

The use of a Communities of Practice model for creating academic peer support groups to investigate the integration of social software and elearning and mobile technologies into tertiary education has proven to be more successful and a better use of resources than general workshops for academic staff. IT phobic tertiary academics have been transformed into educational technology evangelists, and the participation of senior management in COPs has created a buzz throughout the institution. Academics who have participated in COPs feel better prepared for today's technology adept learners. While still in early days, the uptake throughout the institution of COPs for educational technology is encouraging, and leading to collaborative projects between CTLI, academics and students. Staff who previously struggled with integrating technology into their pedagogical approaches are now implementing mobile learning projects with students, and thus we are seeing the awareness and uptake of mobile technologies in tertiary learning increase at Unitec. Key to the models success is its flexibility: recognizing that every COP formed is unique, requires negotiable content, motivational goals, and appropriate access to resources. Every COP will require a different approach for nurturing and motivation, however it must also be recognised that not all starting members will finish. Finally, the guidance of a Technology Steward is critical in establishing and guiding each COP in their investigation and use of technology.

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USE OF MOBILE PHONES FOR LANGUAGE LEARNING AND ASSESSMENT FOR LEARNING, A PILOT PROJECT

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ABSTRACT
The benefits of mlearning in language education have been widely documented (Kiernan & Aizawa, 2004, Schwienhorst, 2000, Appel, 1999). However, while projects using mobile devices and computer-mediated communication have been reported on from third-level language education, the use of mlearning in second-level education has been somewhat overlooked. This paper examines the use of mlearning in second-level education in Ireland for teaching and learning Irish.

The National Council for Curriculum and Assessment (NCCA) in partnership with the National Centre for Technology in Education (NCTE) initiated a pilot project, at the request of the Minister for Education and Science, to investigate the use of mlearning for teaching and learning Irish. Learnosity were contracted as technology partners, to design and develop the mlearning system and provide technical support for the duration of the pilot. Learnosity is a specialist e-Assessment and m-Learning company based in Ireland, with clients in Ireland, the UK, Asia and Australia.

A five-week pilot project took place in a school in County Meath, a rural area close to Ireland's capital city, Dublin. An mlearning system was deployed in this environment with the aim to facilitate school-based oral assessment and students' self-assessment, increase students' communicative competence and motivate students to learn Irish with the fun and familiar props of a mobile phone and web-chat. The mlearning system proved useful and popular with teachers and students alike.

Author Keywords
assessment, language, mobile phone, instant messenger, podcast, voice biometric

INTRODUCTION
"The way to bring a language to life is to be able to converse in it every day. The Irish language is interwoven with our history and our cultural heritage – we need to nurture and preserve it and pass it on to the next generation,"
Irish Minister for Education and Science, Mary Hanafin, 11th March 2007 (Department of Education and Science (DES), 2007)
While English is the first language of the vast majority of Irish people, most children learn Irish as a second language from the average age of 5. Despite years of schooling in the language, a great number of students leave school in their late teens with a less than satisfactory grasp of Irish.

The way in which to educate Irish students in their once native language is a subject that has long caused controversy. Students' attitudes to the usefulness of learning Irish have been shown to decrease as their years of schooling progress (Smyth, Dunne, McGoy & Darmody, 2006). It has been argued that the apparent lack of enthusiasm towards the Irish language is ultimately leading to the cessation of conversational Irish amongst young people and the language is slowly dying out with each new generation. Research has estimated that the Irish language will no longer be spoken as a native language at home in any Gaeltacht or native Irish-speaking area of Ireland by 2027 if current trends continue (Siggins, 2007).

Earlier this year, in an attempt to promote the use of oral Irish language, the Minister for Education and Science announced a significant change to the proportion of marks awarded for oral (spoken) Irish in the State examinations; the Junior Certificate examination taken by students aged 15-16 and the Leaving Certificate examination taken by students aged 18-19.

With these changes applying to students enrolling in First Year in 2007 it means that in 2010, there will be 40% of marks available for the optional oral examination in the Junior Certificate and 40% for the oral examination in the Leaving Certificate in 2012. This is a two fold increase at Junior Certificate level, and a 60% increase at Leaving Certificate level.

To facilitate the change and emphasise the importance of student oracy, the Minister also initiated a pilot project to investigate the use of Information and Communications Technology (ICT) in the teaching and learning of Irish.

In a country where the number of mobile phones exceeds the population (ComReg, 2006) mobile devices can play a vital role in the teaching of languages. Not only does mlearning use technology that most, if not all, Irish teenagers are thoroughly familiar with, mobile phones have an added advantage in the field of language learning, summed up eloquently by Clark Quinn, the director of cognitive systems at Knowledge Planet, and cited in Shephard (2001);

"The mobile phone has one facility that makes it better than most PCs. It has been designed to deliver audio. You can listen to, or even talk with a real person. It is this mix of audio and text that make delivery of certain types of learning content possible."

Problems with large scale Oral Assessment
Given that second-level teachers do not as a rule participate in the assessment of their own students for state certification, the compulsory assessment of oracy in the Leaving Certificate examination in Irish is done through interview by a visiting examiner, the latter generally being a teacher from another school. This practice is already posing significant logistical challenges for schools, with the examinations commission finding it increasingly difficult to persuade teachers to act as examiners (Flynn, 2007). For the Junior Certificate examination the oral test is optional, and is done by the students' own teachers. The take-up is less than 1%. Given such circumstances, it is virtually impossible to provide oral Irish examination at Junior Certificate level on a mandatory or optional basis to a large candidature. One of the aims of the mlearning pilot project was to ascertain whether ICT, including mobile technology, could facilitate school-based oral assessment.

PROJECT DESCRIPTION
The pilot project took place in a rural school over a five week period. 69 second year students aged between 14 and 15 and their three Irish teachers participated. The aims of the project were to:

- promote oracy in Irish through audio-lingual and more communicative methods

- increase student motivation through the use of familiar technology

- increase student use of the four skills- reading, writing, speaking and listening- in Irish

- help students become more competent in Irish

- promote the use of Irish for communicating

- investigate the use of ICT in the assessment of students

Ultimately the aim of the project was to trial a possible ICT solution to promote oracy and facilitate in-house oral assessment with a view to ascertaining the potential for using mlearning for large scale examinations.

Mobile telephones, laptops, the internet and a text-based web chat application were deployed as part of the five-week project. The second year Junior Certificate students participating in the pilot project were supplied with a mobile telephone for the duration of the initiative.

It is imperative to note that the school which participated in the trial demonstrated how the project could succeed with limited facilities and without the cushioning of a school well-equipped with technology. The participating school had no technical support staff and students were being taught in temporary buildings that included corporate boxes in a local horseracing course. The unconventional schoolrooms meant that teaching was called to a halt each time a race meeting was scheduled.

Mobile phones in language practice and assessment
In order to access their practice and assessment sessions, students use a mobile phone to dial a specific phone number to access an Interactive Voice Response (IVR) system. They then pass a log-in process by keying in individual student numbers and PINs into their mobile phone. They are then presented with a series of ten question prompts, randomly selected from a much larger question bank. Students verbally respond to each prompt and their responses are recorded. Students progress through levels - each consisting of twenty questions of a specific difficulty. Different topics are practised and assessed, including sport, music, television and general knowledge. These topics were chosen by the

teachers involved from their schedule of work and reflect the topics in the Junior Certificate syllabus for Irish.

The responses are saved to a server as WAV files which can be played through a web interface and marked online by a teacher. The answers can also be podcast, bringing with it a realm of opportunities for both teachers and students. Teachers can subscribe to a podcast of student answers and mark them at their leisure. They can also highlight a particular answer as an "exemplary" answer and students could subscribe to a podcast of the exemplary answers on their iTunes/iPod. Students can also subscribe to hear their own answers.

Where a student's response is deemed incorrect or lacking, the individual student response was set alongside an exemplary answer for that question. Students can later compare their response to the exemplary answer and re-record their answers. Teachers decide when students move on to the next level of questions and which questions need to be re-answered within any given level.

Students work their way through a series of levels. When marking the answers, teachers will provide detailed feedback to justify the mark given. A feedback booklet can then be sent to the student by email or printed out by teachers as required. This feedback serves as a portfolio of competence for students.

Biometric Voice Verification
Recommendations for the expansion of this pilot project (starting in the 2007/2008 northern hemisphere academic year) include Biometric voice verification. Biometric voice verification uses spoken words to calculate a unique digital representation of an individual's voice. Students will login using their voice, and have each of their Irish language responses verified against a previously recorded voice-print. Biometric voice verification would facilitate the extension of the use of mobile technology for reliable and secure on-demand, high-stakes oral exams. If biometric voice verification was used and assuming the student is sitting an "open book" examination, it would be possible to allow students complete their oral examinations from home, unsupervised.

Mobile phones in vocabulary learning
Educators have recently voiced concern about the detrimental effect the rise of text messaging is having on teenagers' vocabulary. Earlier this year a chief examiner in the Department of Education and Science stated that text messaging posed a significant threat to writing standard in English due to the use of phonetic spelling and lack of punctuation (Flynn, 2007a).

While the aforementioned threat may well be present, text messaging was utilised during the course of the pilot project text messaging to attempt to extend students' Irish vocabulary. Each day, one Irish word or phrase was sent by SMS to students' phones. The text messages, scheduled to arrive during Irish classes, were selected by teachers from a range of topics similar to those mentioned for the voice-prompt system. Students were required to incorporate the word or phrase into Irish conversations during their school day. Students were also obligated to use the phrase during the course of their weekly text-based web chat (see below).

Text-based web chat
Student practice and assessment during the pilot project was not solely confined to mobile phones. The trial also incorporated a teacher-monitored text-based web chat for students to communicate in Irish with their classmates and teacher. It was hoped this portion of the project would promote students' competency in Irish by using familiar tools. The application also promoted an alternative form of communication to facilitate students with any hearing and/or speech impairments.

The benefits of text-chat in education, especially in the field of language learning, have been widely documented. Research has found that text-chat learners participate more than in face-to-face conversations (Kern, 1995) and produce more complex language structures (Vetter and Chanier, 2006).

As part of the Irish pilot project students took part in a text-chat lesson once a week on laptops supplied to the school. Once students had logged-in they would be randomly assigned a partner to chat with. Chat partners were kept anonymous to alleviate the negative aspects of peer pressure. The teacher could also be an anonymous chat partner, targeting students with varying levels of competency and prompting them through chat to reach their maximum potential – students requiring more assistance could be helped along with scaffolded conversation while more advanced students could be challenged with more complex topics.

During the course of the web-chat students had a link to an online dictionary. This provided some of the scaffolding (Wood, Bruner, & Ross, 1976) necessary to support students' language production. Access to and use of computerised bilingual dictionaries has been reported to *help stimulate vocabulary learning* and help *all students to process new expressions rapidly and effectively* (Loucky, 2002: 132).

The text-chats were monitored in real-time by the teacher. The teacher's control on the system meant that conversations could be interrupted if students needed to be redirected in content or target language being used.

The text of the conversations was also saved to script for later analysis. As with the mobile practice sessions and assessments, copies of the text conversations could be marked with each student receiving feedback. Students could also access their saved scripts to facilitate self-assessment.

PILOT PROJECT EVALUATION
The pilot project was evaluated using teacher and student questionnaires, teacher reflective diaries, impromptu feedback from students and teachers gathered in the school and observation.

Both students themselves (67% of respondents[1]) and teachers stated that students had made progress in speaking Irish as a result of participating in the pilot project. Students remarked on progress made in comprehension, competence, grammar and vocabulary. Students regarded the integrated technologies as a positive move from more traditional methods of learning Irish. They embraced the 'new age' technology and it proved to break down barriers to students' learning and speaking of Irish. 95% (n=61) of respondents reported that they had 'enjoyed' using the technology for teaching and learning Irish. Students also reported a reduced amount of pressure in communicating through Irish using the integrated technologies than they usually experienced in face-to-face settings in the classroom. Students' abilities to learn autonomously were enhanced – the technologies facilitated learning at any time, in any place and at the students' own pace. 93% (n=60) of students recommended that other students should also be given he opportunity to use the technologies for learning and practising Irish.

Challenges identified by students all related to the workings of the mlearning system. They made suggestions for improvements to the system should the pilot project be extended. Suggestions included more robust call facilities to avoid dropped calls and improvements to the quality, volume and speed of delivery of the recorded prompts.

Teachers commented positively on the shift from more teacher-led learning to student-led learning that mlearning allowed. Teachers noticed increased motivation and student interest for using Irish during the pilot project. They stated that students found using the technologies more interesting and fun than traditional learning methods. Teachers also noticed that students learned certain topics faster when using the technologies than they had done using more traditional methods. Teachers' perspectives on the impact the technologies had on their own teaching style were also positive. They reported enjoying the shift from providing feedback in a traditional manner using 'a red pen' to more modern ways via Podcast or feedback sheet. They also commented favourably on their increased ability to hear more from those students who are usually shy in the classroom. Teachers commented on the success of the text-message delivery of Irish vocabulary – to such an extent that students requested that they could receive vocabulary during their Summer break to their personal mobile phones.

Challenges identified by teachers included increased time commitment for meeting to discuss the project progression and providing feedback on the high number of students' recorded responses ('time consuming but well worthwhile'). Teachers also made suggestions for further features and improvements to the mlearning system should the pilot project be expanded. All feedback was noted and assisted in shaping recommendations for any future use of mlearning for teaching, learning and assessing Irish.

CONCLUSION
Keegan (2003) says mLearning will provide the future of learning. This statement has proven true for this short pilot project and it has provided an insight into the role mLearning could play in the future of the Irish language.
The success and impact of any mLearning project, however, can not rely solely on the technology provided. The ability of teachers and students alike to embrace the change is vital. Any larger

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[1] N=61; n=57

implementations of this project, which may follow over the next few years, would employ a number of different strategies to ensure students and teachers enthusiastically "opt-in" to learn, practise and assess in this way.

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BLUEPRINT FOR AN ADAPTIVE TRAINING - VIRTUAL LEARNING ENVIRONMENT (ADAPT-VLE) FOR THE TRAINING OF DENTISTS

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ABSTRACT

This paper examines and proposes the design of a framework that allows the creation of an extended virtual learning environment (VLE) for the mobile user. The model incorporates the novel key element of an adaptive learning process mode l which dynamically adapts to the learners interactions within a managed and structured application. To be able to create a dynamic workflow in an interactive learning session, the use of evidence based learning, underpinned by a knowledge based and process modeling approach, including haptics will be discussed. The haptics are integrated within an object oriented view of modeling the learning environment. The context of training and maintaining skills in dentistry provides a challenge to the application of this concept.

Author Keywords
Evidence Based Learning (EBL), M-learning, Haptics, Knowledge Based Engineering (KBE), Virtual Learning Environment (VLE), Common Computational Model (CCM),

1. INTRODUCTION
1.1 Context
Over the past five years medical and dental education, and other aspects of professional clinical practice and the wider socio-medical/dental environment, has changed and continues to change significantly. In serving a wider and more diverse community of patients, there are ever more demands on the professional to perform at the highest levels of proficiency.

To maintain this delivery of healthcare, and confidence of the public, professional development is now perceived as a life long learning endeavour for the practitioner. It is seen as a relevant and vibrant process. Within the United Kingdom continuing professional development (CPD) is now mandatory and a legal requirement for the dental profession and for Dental Care Professionals (DCP); the emphasis being on eliciting, acquiring and integrating a type of expertise and knowledge to benefit the practitioner. It will therefore also be of interest to healthcare professionals who wish to upgrade their skills and students who are studying to become health care workers or medical practitioners General Dental Council (2002). However, there are time constraints in fulfilling these requirements, and in ensuring positive outcomes from the learning. A new mobile adaptive solution (ADAPT-VLE) is described in this paper which is grounded in Evidence Based Learning and Knowledge Based Engineering (KBE) with additional innovative solutions utilizing the sensation of touch (haptics).

1.2. NHS Clinical and Consumer Issues
In 2003, the total UK expenditure on NHS and private oral healthcare was £3.2 billion. About 70% of this expenditure was a direct consequence of dental caries. If the 24000 dentists and supporting clinicians working in UK Primary Care were all operating to current best practice standards, such costs could have been eliminated. The proposed changes of provision in primary care dentistry in the NHS and a more preventive approach will help. However, the proposed **(ADAPT-VLE)** framework is based upon a wireless on-line technology model will maximise professional capabilities by providing enriched facilities, 'any-place, any-where and any-time' CPD, saving travel time and expense. If each worker saved two hours a week not traveling to courses, the time spent in dental practice could be increased by at least 6% in a 35 hour week. Chief Dental Officer (2007).

There will be increased training accessibility by more remote vocational users who have poor or no connectivity. Patients will benefit in terms of the quality and availability of care as clinicians will be more knowledgeable, skilled and available. Furthermore, the infrastructure supporting a working model of **(ADAPT-VLE)** will create employment e.g. for wireless technologists and instructional designers. New industries will build on the new virtual reality capabilities.

1.3 Continuing Professional Development (CPD)
Since 2001, it is a statuary requirement for all UK registered dentists to undertake 250 hours of Continual Professional Development (CPD) every five year Chief Dental Officer (2007) . This CPD is largely undertaken through face to face courses with some computer assisted learning eg CDROM's. However,

there is much potential to develop and exploit high quality e-learning resources through a supported 'virtual learning environment'.

The **(ADAPT-VLE)** approach will aim to improve the quality of delivery and uptake of online CPD thereby increasing the skill and knowledge base in the workplace. It should provide a paradigm applicable to other professions.

Current web based e-learning CPD initiatives in dentistry have not proved particularly successful. Although the younger generation are familiar with e-learning, the impact on dental professionals in Higher Education (HE) is still to be established. Many HE learners and teachers are unsure what e-learning means and some see it as another way of delivering paper based resources. However, Reynolds *et a*l (2007) demonstrated a positive impact on dental undergraduates of using mobile technology - portable digital assistants (PDA)s - in a clinical environment. Irrespective of their ICT skills, all students in the pilot study were able interact with their virtual learning environment (VLE) and wanted the PDAs to be available for both work and personal use. The devices were small with smoother surfaces than a standard PC, keyboard and mouse, and without trailing wires, there were clear health and safety advantages of using such mobile technology.

The proposed advanced flexible learning platform, will focus on mobile connectivity and being standards-based, it will allow (VLE) and other key elements such as e-portfolios and support functions to reside within it. A marketing and presentation intervention will be undertaken to assess the effect of the media on the uptake of courses. W3C Web Ontology (2007). It will be essential to obtain input and feedback from end users (all groups of dental workers) at all stages of the project as the (**ADAPT-VLE**) platform is built. Feedback will be inbuilt e.g. recording hours of use, subjects covered, and also obtained from a panel, drawn from all groups including patients, workshops, online and telephone contacts.

Evaluation of this development of a universal platform to deliver CPD will allow guidelines of high quality educational delivery to be formulated, available to all healthcare fields.

2. DEFINITIONS

What Is Evidence-Based Learning?

Evidence based learning in healthcare is the practice of integrating individual clinical expertise with the best available clinical evidence from systematic research. Generally doctors and dentists combine both their individual clinical expertise and the best available external evidence. The process begins and ends with the patient) Elson *et a*l (2003). A series of defined steps are involved in this process to assist the practitioner in their thinking starting with history taking and examination of the patient, the practitioner then formulates a differential diagnosis which lists the potential conditions and leads to investigative processes to define the best solution to the problems. Although there are clear lines of exploration and analysis in reaching the definitive diagnosis and appropriate treatment plan, computers can be instrumental to this process in searching for the scientific evidence that is most likely to answer the question. This evidence is combined with the clinical experience from other patients with similar problems to answer the question, perhaps a secondary referral to an expert. Finally the outcomes and options are discussed with the patient.

What Is Haptics Technology?

Touch is fundamental to the way we perceive objects and is critical to dentists when manipulating and exploring the physical properties of an object, by the feedback through our fingers when scanning an objects surface, to sense it, either directly or through a secondary medium of a tool. To manipulate it we apply force to it while simultaneously observing the results of these actions. Visram *et a*l (2005) Until recently vision has had the primary role in our interactions with virtual entities in VLE. The field of technology where the application of touch sensation and control is used in the interaction with computer based applications, is known as haptics.

2.3 What Is Knowledge-Based Engineering?

Knowledge based engineering (KBE) is a method that represents a merging of object oriented programming, artificial Intelligence (AI) techniques and computer aided design technologies. KBE systems aim to capture product and process information in such a way as to allow businesses to model their products, and then use the model to automate all or part of their processes. Chapman *et a*l (1999) The emphasis is on providing, informational complete product representations, captured in a common

computational model (CCM). The CCM represents the business intent behind the product design, storing the how, why and what of a design. The CCM is an internal computer representation of the product business process and can contain information on both the product and processes that go to create the part. Attributes can describe geometry, functional constraints, material type and processes such as the methods required to analyse, link to external systems and cost a part. The KBE product model can also use information outside its product model environment such as databases and external company programs. The ultimate goal of the KBE system should be to capture the best domain practices and expertise into a corporate knowledge base. KBE methodologies should provide an open framework for formally capturing and defining the process of VLE creation. Commercial KBE systems use various mechanisms to create a desired application and provide toolkits to facilitate the application build.

3. MOBILE LEARNING (M-LEARNING) EXTENDED

Mobile learning in this context is seen as both using mobile technologies and in the user being mobile, choosing to access their teaching and learning from portable or fixed locations in a mobile society.

This paper proposes describes how pervasive technology coupled with the unsullied wireless internet technology and video conferencing, haptics and the learning objects teaching content model, can be the driving force that changes the way, evidence based practice takes place. The provision of portable, light-weight Personal Access Devices (PAD), enhanced with flash technology and voice commands are enabled globally by wireless connections to the internet, For example, in dentistry, the use of the Internet using laptops and web casting was evaluated as part of a European Educational Social Fund Programme (ESF) providing up-to-date CPD for 100 dental practices and pharmacies (Jones and Reynolds (2005).

Due to the change in the pattern of practitioners working lives and the greater variety of specialised skills needed at short notice, a just-in-time and mobile learning approach offers a more personalised solution. This suits a design which uses learning objects in a relatively granular fashion. Just as with manufacturing, it is an approach that can only work effectively where it makes use of the latest technology: in this case mobile, 3D, object orientated and wireless technologies.

3.1 Object Orientated Infrastructure and 3D Modeling

The paper also describes how the concepts of real world objects, classes and inheritance, which are the basic building blocks for object oriented technology along with 3D modeling graphic and web-based design application can form foundations for evidence-based learning applications and an engine for FAQ. Chapman *et al* (2001) The object oriented infrastructure behind this new web-based technology will allow professionals, who have moved out of the teaching environment to experience and take advantage of new opportunities to learn: m-learning, distance learning and virtual education. Moreover, the conceptual **(ADAPT-VLE)** framework forms a backbone to a structure, which provides a means to providing tailor made courses, whose component units are independent and autonomous and assimilated Just-in-time for the mobile user. These learning objects are powerful concepts that are used to promote evidence-based learning as self-standing, reusable, discrete pieces of content that meets an instructional objective. Additionally the establishment provides for global coverage, enabling professionals to update their professional and surgical skills by using small hand held mobile haptic devices which form a virtual learning tool as they give force feedback sensations. This coupled with Virtual Studio based facilities and surgical procedures integrated by vector (Flash) and Real Time Video based and zoom technology and educational data mining, enables them to balance the conflicting demands on their professional time. Elson *et al* (2003)

The evidence for success of this singularity has been verified by a feasibility case study project. This involved 3D scanning of skeletal artifacts such as the mandible (utilising Roland Piza Air & 3D Laser Scanners).The rudiments of this case study were proven by the forerunner project (WISDOM – Wireless solutions to Dental Online Museums) to embrace and perpetuate the skeleton for the object model . Elson *et al*.(2003)

The paper further illustrates how the manifestation of the structure, embodied within the confines of the case study, gave rise to the formulation of an International Virtual Dental School (IVIDENT) http://www.ivident.info . It will enable professionals to complete accredited courses in specialised areas of study, from the surgery or comfort of their own home, using mobile technologies at a time convenient to them.

4. MATERIALS and METHODS
The ADAPT-VLE Framework (4.1) and System Requirements will be described (4.2)
4.1 THE ADAPT-VLE FRAMEWORK
The primary aim of ADAPT is to facilitate a discovery and interactive approach in their training domain. It is not a prescriptive learning tool forcing the user into a set sequence of events although the user will be given objectives. The training will mimic real life wherever possible so that users may be confronted with a situation where they have to make a decision based on the evidence provided on a case basis. The training also needs to be delivered across geographical boundaries though the web and across heterogeneous systems. A way to describe how ADAPT-VLE will work is to step through a use case; we shall walk through a dental training scenario looking from the trainer, practitioner/trainee (user) and ADAPT-VLE (system) point of view.

4.1.1 EXAMPLE OF CASE- BASED TRAINING- PERFORMING A RESTORATIVE PROCEDURE ON A TOOTH (Filling).
The professional undertaking this case based task will have access to a comprehensive history of the patient, differential diagnoses and treatment options. Part of the examination will reveal caries in a tooth that will require restoration. Decisions on the correct method to restore the tooth and this will require a virtual model to be set up including haptics for the correct decisions and actions to be taken, based on the current best evidence base knowledge.

4.1.2 TRAINER VIEW
The trainer will need an underlying appreciation of pedagogical best practice when working in VLEs. They must also know theirs and understand their students' needs when creating lessons and discovery learning opportunities.
The process involved to create a lesson – a case based task - could be summarised as follows:
1) Using the system process modeling tool to create the 'treatment' lesson.
    a. Retrieve from the dental training repository a predefined process model, in this case a monitor/feedback model and name it.
    b. Step through the process model:
        i. Add landscape and assets to be used in the training session and set properties:
            1. Patient profile, records and full history
            2. Mouth 3D model
            3. Restorative options
            4. Dental tools/machines
            5. Haptic hardware and software
            6. Question and Answer user interfaces.
            7. Documents
            8. Video
            9. Sounds
        ii. Create monitor relationships between assets and select monitoring methods, as shown in Figure 1 (i.e. Parse file or db query)

        iii. Create feedback actions from monitor relationships i.e. show video, step through correct procedure, email tutor etc.
    c. Save lesson to repository.
    d. Allocate lesson concerning the treatment plan of performing the tooth restoration itself to a user/s.

FIGURE 2. BASIC MONITORING SCENARIO
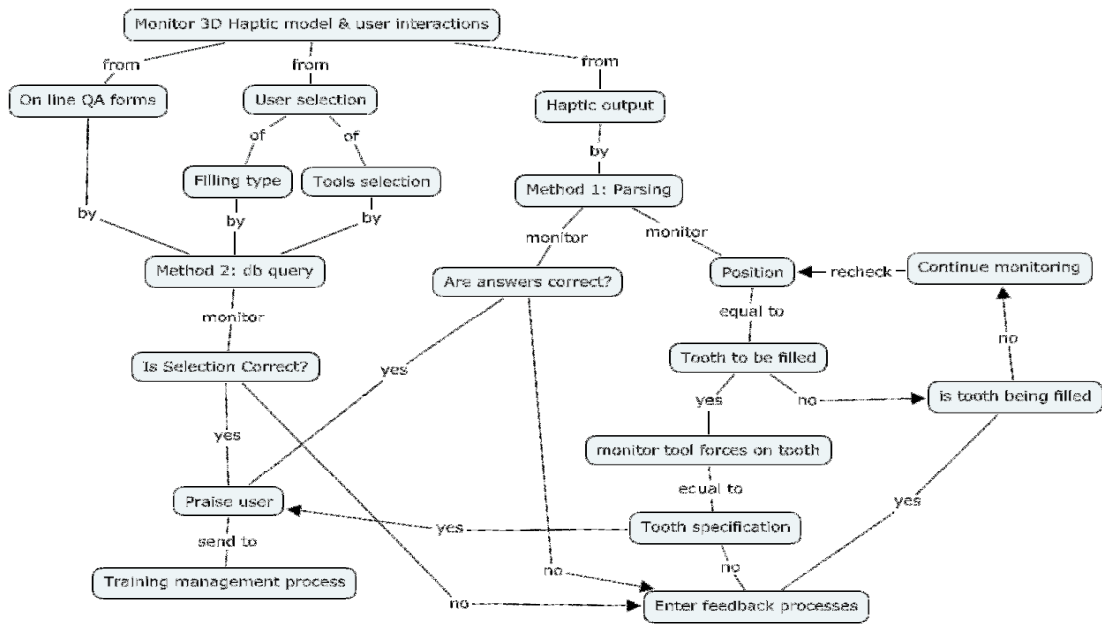
4.1.3 PRACTITIONER DR TRAINEE (User)

To update their existing skills, hone procedure or learn a new technique, the steps include:
1) Logon to their allocated training space and select a lesson.

2) Interact with the lesson in a natural freeform way using the haptics and user interfaces, the user is allowed to make a choice in how they proceed monitored by the system, a choice might be:
   a. Read patient notes.
   b. Answer Q&A user interfaces.
   c. Select tools and Investigate patients history and oral conditions.
   d. Identify treatment options of condition, in this case a carious tooth/teeth.
   e. Decide a treatment plan and apply.
   f. Decide post procedure process and apply.

3) Receive feedback and assistance as required. Note: feedback may be passive for example; the user may have chosen a gold restoration instead of composite or amalgam. At the end of the session the system may highlight different costs / health trust preferences or indicate that the patient should have been asked if they were on any medication if that information was left out of their notes. Proactive in the case of the user choosing either a healthy tooth or one that does not yet need any operative intervention stopping the session, highlighting the problem and showing media, for example on the progression of caries and remineralisation of teeth.

FIGURE 2 USER PROPOSED USER INTERFACE
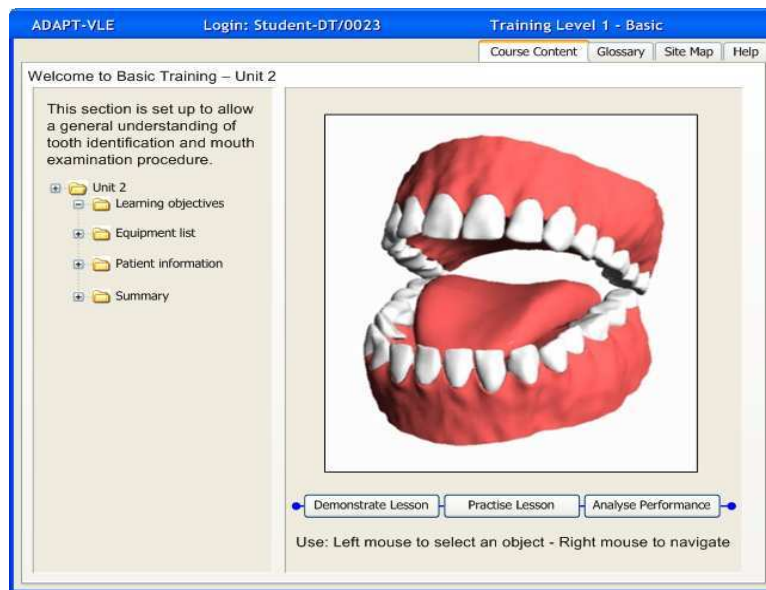
4) Save their session at any time.

4.2. ADAPT-VLE SYSTEM REQUIREMENTS

The above case (4.1) demonstrates that the framework needs to be able to provide for the visual construction and delivery of learning programmes to achieve this we will need to:

1) Model real world entities such as teeth, people, tools, costs etc.
2) Model real world activities such as diagnosing, operative procedures, monitoring progress, tutor intervention etc.
3) Manage data and information in the form of documents, videos, sounds, 2D and 3D models etc.
4) Integrate external components such as haptic software, devices and databases.
5) Enable relationships to be built between 1, 2, 3, and 4.
6) Provide the ability for the user to model their domain for reuse in a meaningful way.
7) Enable the development of dynamic process models representing the desired training to be undertaken using 1, 2, and 5.
8) Allow the development of a repository to manage, control and store 1, 2, 3, 5, 6 and 7.
9) Manage, control and monitor the user within a secure environment.
10) Be delivered over the internet.

To deliver a framework that has architecture that is both flexible and extendable, allowing the user to structure multiple views of their domain and the methods of user interaction it is necessary to look beyond present VLE methods. Outside of the VLE community there are many examples of domains such as the military, aerospace and automotive that also need to elicit, acquire, manage, utilize and model their knowledge and create systems that infer as to the state of a model in a distributed manner. One such technique being employed to satisfy our framework requirements is that of Knowledge Based Engineering (KBE).

4.2.1 USE OF KNOWLEDGE-BASED ENGINEERING

KBE methods will provide an open framework for formally capturing and defining the process of VLE creation. Commercial KBE systems use various mechanisms to create a desired application and provide toolkits to facilitate the application build. This project examines a limited set of the mechanisms needed for VLE; demonstrates the four proposed stages to ADAPT-VLE. (Fig.3)

FIGURE 3 ADAPT- VLE STAGES
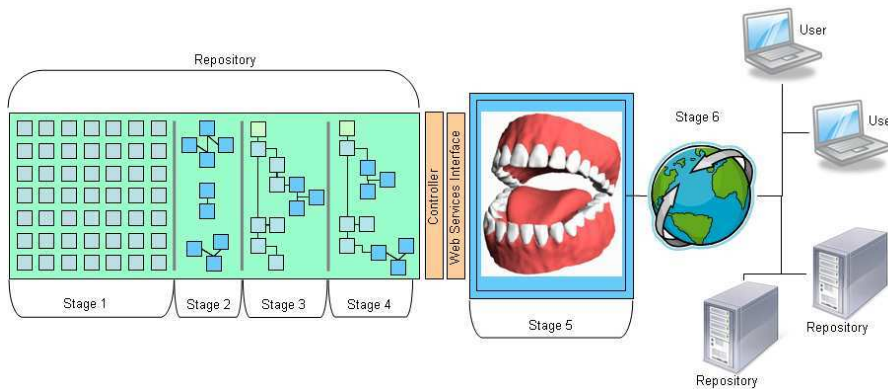
USER INTERFACE (UI)

The UI is a method of gathering input and providing feedback. KBE systems provide internal facilities to create a customised UI's. In ADAPT-VLE there needs to be two distinct levels, the VLE developer and the trainee/user.

Stage 1 uses the repository, part object and UI's for the collecting, storing and managing of the individual assets and entities required to build our VLE application. Stages 2 and 3 will build more complexity into the models.

Stage 2 are more complex relationships will be developed using our individual assets and entities and programming methods and functions, for example here a generalised mouth model may be created by building up the relationships between the incisor, canine, premolar, and molar entities and adding them to a jaw entity model. We will also include process models such as cutting cavities in teeth, tool selection and patient care models. It is here that computer methods to parse documents, read spreadsheet data, integrate to haptic environments methods will be included, hiding programming complexity from the VLE user and developer (Figure 3)

Stage 3 we are creating a model of our domain, the creation of a VLE for in this case dentistry using the predefined models in stage 2 and individual assets from stage 1, in KBE terms this is called the conceptual model.

Stage 4 the user is using a 3D haptic environment the training session is live and the knowledge base is continually monitoring and validating the user actions and updating the information presented to the user in context to their actions and the objectives of the training (Figure 4)

FIGURE 4 USER PROPOSED PROCESS VIEW- HIDING COMPLEXITY
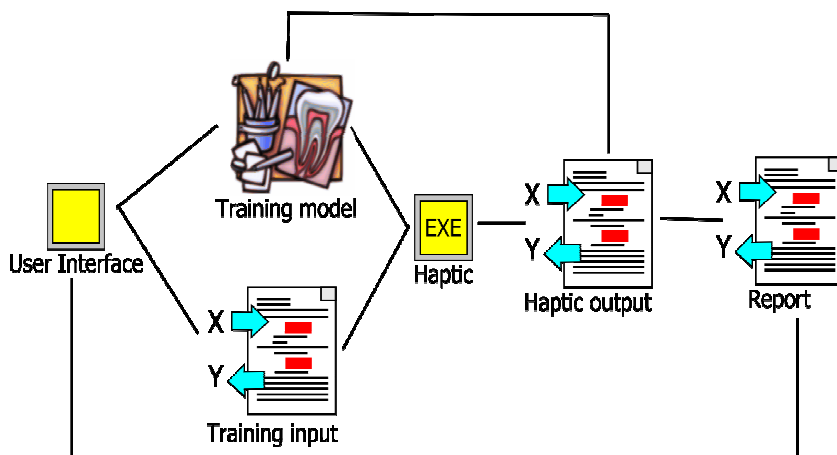
For the management of all stages the user shall be provided the ability to: access the VLE data over the web, define workflow events and triggers, manage VLE models and data access privileges, and track activity at user and project levels. All stages also require the use of a knowledge base / repository, the creation of our 'real world' entities and the ability to build relationships between those entities; this is done in KBE by the creation of part objects all controlled by intuitive user interfaces.

4.2.1.1 KNOWLEDGE BASES/REPOSITORY
The amount of knowledge existing within an organisation may be great. Knowledge is often stored within various media; this often is as non integrated "islands of information". The media can be read and analysed by an individual or by software. The KBE method provides mechanisms to capture this knowledge, storing it in a repository enabling reuse and make it available to the various stages in the VLE life cycle.

4.2.1.2 PART OBJECTS/ ENTITIES
Part objects created within the KBE system form the building blocks of any model, often representing real world objects. For example a tooth model might break down into several main parts such as the crown, root, enamel, dentine, pulp, cementum, periodontal membrane, nerve and blood supply. These parts are affected differently in the progression of craies and subsequent sequalae -, each stage varying the intelligence of the objects. For example primitive objects might only know how to draw themselves, whereas higher level objects will use the knowledge base to make specific decisions regarding their shape, relationships, haptic behaviors and cost.
Part object terminology changes depending on the application domain. As most KBE systems are based on Object Orientated Programming (OOP) methods, they solve problems by defining, creating and manipulating collections of data and procedures called objects. The terminology and concepts behind OOP and KBE relate to how objects are defined, have properties assigned to them, how they interact and how they are combined to form more complex objects Chapman *et a*l (2001).
The object encapsulates the data or properties, and the methods to manipulate that data into a single unit. The class is the template, and the object is specific case. An object with a particular set of values is called an instance, of a class definition.

4.2.1.3 CONCEPTUAL MODEL
In the context of this work the KBE conceptual model can be thought of as ontology, when using the WebOntology working group's definition of "a machine readable set of definitions that create a taxonomy of classes, subclasses and relationships between them". W3C Web Ontology (2007) The decisions made by the system to dynamically create a model will be based on the domain models selected, the user interaction, haptic inputs and the knowledge bases.

5. CONCLUSION - NHS PLAN
Within the policy for NHS dentistry (Chief Dental Officer (2007) there is considerable emphasis on changing the service from a predominantly "repair service", with an emphasis on a service based on prevention, long-term care and the whole community. When coupled with the current shortage of all classes of dental worker, the requirement that all health care workers (including dental workers) must undergo a continuum of lifelong learning, this policy results in the requirement for the expansion of dental education at all stages for all dental workers.

Furthermore a commensurate increase in the number of trainers is problematical because of the long and rigorous training pathways in both dentistry and education to ensure safety and confidence of the public. The blueprint proposed in this paper will enable both academic and practical techniques to be delivered in an innovative, student centred, non repetitive way by teachers, thus freeing them up for other tasks such as research and service provision. The proposed ADAPT-VLE model will thus provide a mechanism to help overcome such problems but also provide a framework for other specialties.

The Knowledge Based Engineering method traditionally used in product process design in the military and aerospace sectors and haptics will enhance the virtual learning environment proposed in this project. With such innovative approaches, it will be possible to provide a mobile training model that dynamically uses relevant media and evidence to support the actions of the user in real time. This is in

stark contrast to more current fixed non exploratory training environments. Modeling the process to compliment an evidence based learning strategy will allow the models to evolve and bring to bear relevant information as the user requires it, either passively guiding them along a process or proactively presenting them with alternatives or suggestions. For this the dental context has been chosen as a case based scenario such as the requirement to make decisions and perform the restoration of a carious tooth.

By the use of a web based repository and using the KBE object reuse and process model strategies training can be dealt with on an international scale. The use of a Common Computational Model (CCM) allows instant update of relevant information to the user in a form that make sense to their requirements, as standards, procedures or legislation change so to will all the generated models that link to this knowledge base giving the end user up to date information instantly, enabling them to meet the demands of training and CPD, keeping them at the forefront of their profession and meeting the demands to deliver the highest quality of healthcare in an ever mobile society.

Without the approach ADAPT-VLE   to increase the use of e-learning to supplement existing resources, it is difficult to see how the NHS Plan, in general, and policies for expanded numbers of dental workers and their lifelong learning, in particular, can be met., Chief Dental Officer (2007).

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DEFINING THE HANDHELD COMPUTER FOR A FIRST YEAR UNIVERSITY STUDENT: IS IT A 'HANDY' ACCESSORY OR AN ESSENTIAL LEARNING TOOL?

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ABSTRACT

The main aim of this research project was to analyse a first year student group's engagement with their handheld computers (also known as Personal Digital Assistants or PDAs) – not only in activities related to their university studies, but in the broader context of their lives – and to reflect on how this impacted on their overall engagement in the learning process. The other objectives were to contextualise the resulting discussion within the findings about the mobile learning behaviours of the wider student group. The communication preferences and practices of the participants as representatives of the larger cohort were also analysed, including whether owning a PDA impacted on these behaviours. The findings reflected that though the students were appreciative of the opportunity to have and explore an unknown device, they judged it to be an accessory, and not an essential component, to their 'digital backpack'. The analysis leads to suggestions for a way forward in engaging students in a highly digitised world.

Author Keywords
Mobile learning, student engagement, first year experience

INTRODUCTION

When a student answered, 'What was the main way you used your PDA over the past few months?' with the response, '*As a desk accessory*', he encapsulated the key issue raised in this research project. This issue was to assess whether, in the life of a first year university student, a handheld computer was a valued tool or if it was instead, a 'handy' accessory. Currently, though there is a plethora of research on mobile learning, the significance of context and the variations in student populations around the world, and even within the populations in Australia, mean that the findings of this Western Australian project can complement the discussion about best practice and offer insights into how to engage students of the net generation. In Australia there are 4.5 million Net-genners who were born between 1978 and 1994 (Sheahan 2005). These young people, who can also be referred to as digital natives (Prensky 2001), are naturally conversant with Web 2.0 applications which are "all about moving beyond content delivery to personal publishing, ease of use, interactivity, collaboration, sharing, and customisation" (Cochrane, 2006). As these capabilities exist on mobile devices, it is assumed that these students would exhibit a preference for having them. This paper looks at only one such mobile device, a handheld computer, also known as a Personal Digital Assistant (PDA).

In this research project, the manner in which a group of engineering students mediated their world – explicitly the aspects related to their university studies – with a handheld computer, was observed and interrogated to gain insight into how this device engaged them in the learning process. So, why does a busy, new undergraduate (engineering) student welcome the opportunity to explore such a digital device? *'I was interested to see if it could be handy for my course. I'm pretty interested in gadgets generally.'* This comment from one of the participants in the a mLearning project at Curtin University of Technology exemplifies the attitude of not only the project participants, but rather it represents the attitude of many of our 'digital natives' (Prensky 2001). The project, funded by Hewlett-Packard gave a group of students the opportunity to explore a 'gadget' (the iPAQ 5550) and decide just how 'handy' it could be. The findings raised questions about defining tertiary learning and the role of digital tools in this learning.

PROJECT AIMS AND KEY QUESTIONS

This paper will present the findings based on the interview data from the Perth engineering participants in the context of larger quantitative data obtained from surveying all the first year engineering students in 2005 and again in 2007. The researchers observed and speculated how and why the students positioned the devices in their 'digital backpacks' and integrated them into their studies and into their lives generally. More specifically, it sought to examine whether having a PDA influenced their social and educational communication. These communication experiences could be further deconstructed to include: connection and interaction with other participants – both locally and those in Malaysia; increased knowledge and competence in use of ICT (Information and Communication Technology) tools; and adjustments in their interactions with others and with self.

- In assessing how and why the student participants used the device, these were the key research questions:

- How would the students integrate the PDA into their 'digital backpacks'?

- Would their attitude and use of the PDA change over time?

- Would there be any distinctive changes in their communication behaviour over the time (12 months) of the project?

Background

Handheld computers have been used in higher education for approximately 15 years, however in Australia, the researcher has been unable to find evidence of use apart from in the health sciences (for example at RMIT and at Curtin University of Technology). Oliver & Wright (2002) noted the growing popularity of using handheld computers (PDAs) on North American campuses back in 2002. Contemporary analysis of this phenomenon is complicated by the fact that the merging of several digital devices into one device – for example, the iPhone – makes comparisons and evaluations of any one device – or tool – rather complex. Also, this continual evolution and advancements of digital devices makes labelling one device as a PDA and another as a mobile phone seem a little anachronistic as one can be the other.

METHODOLOGY

First, in February 2005, a survey was done of all the incoming first year engineering students (on Curtin's Perth campus) with another similar survey of the new cohort conducted in 2007. These surveys were reasonably broad as we wanted to gather a picture of the incoming students' digital behaviour. Once we had the 2005 data, we were able to make the purposeful selection of research participants so we could get some rich data. This smaller project was part of a larger Hewlett Packard funded research project. That project involved groups of first year students from Curtin University of Technology's Engineering and Business faculties, in Australia, Africa and Malaysia, from about May 2005 to June 2006, using handheld computers for both structured and informal learning experiences. It was as part of this larger project that 15 first year engineering students on the Curtin's Perth campus were given the PDAs (iPAQ 5550s).

As there were only 15 devices, we chose to use 'maximum variety sampling' (Denzin & Lincoln 1998). The aim was that this would give us an insight into the differences – and commonalities – between the different types of students. The aim was to have participants who ranged from those who had used all the devices and tools to those who had very limited experience. These 15 students were put into groups (see Table 1); two groups consisted of students only from Curtin's Perth campus and the other two groups were a mixture of students from Perth and students from Curtin's campus in Miri, Malaysia. (Fifteen students in Miri were also given PDAs, though these students do not form a part of this study).

This representative sample of students was then interviewed to ascertain how they were using their PDAs.

The interviews

The semi-structured interviews of the 15 Perth based students, in small group settings, during 2005 and 2006 were conducted to not only complement quantitative findings but also to contextualise the findings within the large data about digital practices of the cohort from where these student participants came. Group interviews with more open ended questions (e.g. what are the best things about the PDA?) were held three times during the 12 months of the project to elicit more subtle student perceptions and feelings that may be hidden in the quantitative survey data. The group interviews were recorded and verbatim transcriptions were made of the interview data.

To assess the extent and nature of student use of PDAs and what this all means for student learning and teaching at university. The fluid nature of research in this area means that it is essential to place the findings of this small project within the wider context of the digital behaviour of the participant students' peers.

The qualitative data has been analysed using a grounded theory approach based more on the original Glaser & Strauss (1967, cited in Denzin & Lincoln, 1998). The richness of the conversational data cannot be fully realised through this method (of coding and then creating categories) but it does allow the

researcher to give meaning and create connections to the quantitative survey data. This was done maintaining the integrity of the data.

Apart from initial instructions and support on the technical aspects of using the device, the student participants were not given direction about how and when to use the device. Instead, the participants were told to use the device as much and in as many ways as possible. Interviews were held to gauge their usage patterns and to encourage them to explore and share with each other the variety of ways to use the device in their studies and in other areas of their lives. During these interviews, the students were encouraged to overcome any perceived or experienced technical limitations of the device (e.g. problems with wireless capabilities). The researcher also encouraged the students to attempt to find new ways to use the device in their discipline area – engineering. The potential of mobile devices in professional engineering seemed vast so they were told to play and explore now, as pioneering undergraduates, so they could be at the forefront of using handheld devices in the future.

Finally, the devices were to be used in situated learning environments. Whether this was on a construction site, in their faculty computer laboratories or off campus in their bedrooms, students were to use the PDA when they naturally felt that the device could enhance their experiences. Apart from four of the participants, no one had used a PDA before and none of the group owned such a device.

Reasons for methodology

The survey plus the interviews provide the complement of quantitative data from a large group and rich qualitative data from a sample smaller group. There were only fifteen PDAs and though giving them to a group may be labelled as interventionist, the instructions to the participants were to use the devices as much or as little as they wanted to, and in whatever manner they desired. This allows the results to be generalizable to at least other first year Australian engineering students.

The methodology was based on the basic educational philosophy that learning must be student centred. Learning is also a situated experience and it is a lifelong process. Implicitly then, learning can also be mobile. Sharples, Taylor & Vavoula (2005) claim that as there was no theory of mobile learning, one was required to provide a framework for the highly portable and transitory education that was now intrinsic to the digital world. This gives the researchers a framework in which to discuss the student experiences at the two levels defined: engagement with device and using the device for engagement.

Using a PDA in the learning process captures the essence of student centred learning. The responsibility for the learning process is completely with the person who had the device. This is at the heart of e-learning generally – where engagement in the learning process is driven by the student.

FINDINGS AND DISCUSSION

Relevant findings from the survey data

First, it is helpful to look at overview of the participants who formed the representative sample (Table 1) and also note the demographic of the larger student cohort (Table 2).

Group A	Group B	Group C	Group D
5 students (4 males, 1 female, all under 20 years) Perth only mixed gender group	2 students (2 females; one under 20 years and one under 25 years) These students were matched with 3 students in Malaysia	3 students (3 males under 20 years) These students were matched with 2 students in Malaysia	5 students (male; 4 under 20 years and 1 under 25 years) Perth only group
2 ESL/other language 3 English first language	Both had English as their first language	1 ESL/other language 1 English first language	1 ESL/other language 4 English first language

All of the participants owned mobile phones, had internet access off campus and all frequently used online resources to help them learn. None of the participants owned a PDA.			
3 had laptops	1 had a laptop	1 had a laptop	2 had laptops
1 had used a PDA before	0 had used a PDA	2 had used PDAs	1 had used a PDA before
3 owned iPods or MP3	1 owned an iPod	All 3 owned iPod/MP3	3 owned iPods or MP3
4 used instant messaging	Both used instant messaging	2 used instant messaging	3 used instant messaging
0 blogged or engaged in podcasting	0 blogged or engaged in podcasting	2 blogged and engaged in podcasting	1 blogged 0 engaged in podcasting

Table 1: Curtin Perth campus, summary of engineering student participants in PDA project

		2005	
		n	%
Gender	Female	9	9.4
	Male	87	90.6
First language	English	75	78.1
	Other	21	21.9
Age	<20	76	79.2
	20-25	17	17.7
	26-35	3	3.1

Table 2: Gender, first language and age composition of the larger engineering first year cohort surveyed in 2005

It is also relevant, in this context, to look at the whole student cohort ownership of devices that can commonly be labelled as 'mobile.' In 2005, as the survey was conducted for a larger project, both Business and Engineering students were surveyed about their ownership of four devices: laptops, handheld computers (PDAs), mobile phones and music playing devices such as *iPods* and MP3 players. To support the applicability of this project's findings to the current student cohort, the findings from a 2007 survey of the incoming Engineering students have also been included alongside the data from the 2005 survey. Table 3 shows that a little less than half the students in each cohort owned laptops; very small percentages reported ownership of handhelds (<10%) and the vast majority owned mobile phones (>96%). As was reported in an earlier paper (Oliver & Goerke 2007), there was no difference in ownership levels of these devices for the two cohorts, either when Business students were included or when they were excluded ($p > .05$). That paper also showed that there was a discernable change in the levels of ownership of the music playing devices. 'In 2005, two fifths of students (40.6%) owned a music playing device; in 2007, over two-thirds of students (70.1%) owned them (chi-square, corrected = 65.296, df = 2, $p = .000$)' (Oliver & Goerke 2007).

	Year	n	Yes	Not sure
Laptop	2005	412	47.6%	0.5%
	2007	290	48.6%	1.4%
Handheld computer	2005	409	8.1%	1.0%
	2007	288	5.6%	1.4%
Mobile phone	2005	412	97.6%	0.2%
	2007	289	96.2%	0.7%
iPod or MP3	2005	409	40.6%	0.2 %
	2007	288	70.1%	1.4%

Table 3: Number and percentage of students who reported owning devices

These results indicate that the ownership of handheld computers has not changed much over the past two years with less than 10% of students owning PDAs.

Findings from the interview data

By uncovering repetition of responses as well as connections to the quantitative data, two divergent themes emerged: enthusiasm for the device and eventual disappointment and resignation at its technical limitations.

During the early months, the student participants expressed gratefulness, curiosity and enthusiasm to have a mobile device to explore and for the opportunity for extension (to their ICT knowledge). This was true for all the students from those who were already highly skilled (they liked the chance to be experts (teach their peers) and explore and extend the use of the device. The others were all happy to have a 'new' device. Two of the 15 students failed to participate in the follow-up interviews in 2006. The converse theme was resignation and disappointment with the limitations of the device itself and greater blame / disappointment with limitations of the information technology infrastructure at the university generally, and in their faculty area specifically. This was evident even in the early days of the project. Though the students overcame and forgave some of the limitations (such as poor battery life) other issues such as the inability to access the university's online learning system were not forgiven.

One can theorize from this data that students will discard any ICTs that do not make their learning more engaging and more efficient. The students saw little benefit for such a device to be used on an engineering site; they took photos and movies with their mobile phones and used paper for quick notes/sketches later going back to their desktop or laptop computers to finish complete the work. This left the PDA to be either a game device or an organizing tool. Few opted to use it for the latter purpose. In terms of explicit social ICTs, they had their mobile phones, their iPods or MP3 players and either their laptop or desktop computers (for instant messaging) so another device seemed to be superfluous. When asked to define their basic needs versus their 'dream' needs in terms of ICTs this response summarises the group's sentiments: *'The basic needs of an engineering student are a PC with the latest version of Office, printer, and internet connection and a USB thumb drive – plus a mobile phone; the 'dream would be to have a good laptop!'* They all said that if only they had better access to wireless on campus – then they could see the benefit of this accessory – and that is what the PDA was to them; an accessory to their essential 'digital backpacks'.

A PDA and the learning process

This paper sought to emulate Cobcroft et al. (2006) who in their review of mobile learning research papers, aimed to 'synthesise the literature to identify a realistic vision for the application and implementation of embedded m-learning technologies as they become available'. So too, this paper aims to reveal, via the analysis of this small project, a pragmatic vision for the enhancement of teaching and learning that incorporates the model of learning as a mobile experience but that does not necessarily imply that it should include a specified device. The limitations experienced in this project do not mean

the failure of mobile learning to augment the tertiary learning experience at this university but rather this supports Cobcroft et al. (2006) who show that there is a need 'for a formative framework that progresses past the individual case study to a consolidated approach'. The findings in this project have lead to the following reflections on student engagement in learning:

Learning is pervasive and constructed
Learning is commonly, and simply, deconstructed to occur at a deep level or at a surface level (Biggs 1987) and in higher education it is expected that we enable as much deep learning to take place as possible. Having to negotiate learning experiences with a mobile device, and even in their navigation of the device itself, encouraged the students to engage in deep learning and thus the PDA, in this context, can be judged to be a suitable accessory for university education.

The constructivist theory of learning maintains that people learn through giving meaning to their experiences by building on their past experiences and by creating new knowledge through compiling bits of information in an individual way; that is, a learner constructs knowledge for themselves. Mobile learning complements this learning theory.

Learning as a mobile activity
Mobile digital devices, such as PDA's, give students the choice to learn away from the desk. 'For the era of mobile technology, we may come to conceive of education as conversation in context, enabled by continual interaction through and with personal and mobile technology' (Sharples, Taylor & Vavoula, 2005). People had always learned 'on the move' but current researchers (for example, Frand (2000), Caruso (2004), Sharples, Taylor & Vavoula, (2005) have identified that students are now intrinsically mobile in their learning and that this calls for different ways to theorise learning. As mobile learners, net-generation students embrace and exploit gadgets that enable this learning.

The issue to consider is whether the university's ICT infrastructure will enable the easy – and quality – wireless connection of these mobile devices. Interviews with students who had PDAs in 2005 revealed that it was the lack of easy access to and poor quality of the wireless connections that restricted their use of the device. They all said that they would have used the device more if they could have accessed the Internet more easily. *'This whole wireless issue has reminded me why I put a 16 port WIRED network in my home. It's wonderful that these Pocket PC's can do so much but without wireless internet they lose most of there functionality. I've had to put mine down and take some deep breaths because it's getting a little frustrating. I'm basically experiencing the same issues as P.[I] hope that M is right and the problem will be corrected soon. I'm trying hard to not complain because this [iPAQ] is Free'.* In addition, supporting synchronous and especially asynchronous e-learning formats gives students more choice in how they learn and it also supports the concept that learning is a lifelong process (Singh, 2003). It does not just happen at any one time and it allows students to self pace their learning as they have instant 'start up' on the PDA whenever they wish.

Learning though engagement
When asking questions about engagement one must consider whether the students were integrating the devices into the process of their learning. Simply, were the students accessing anything via their devices that enhanced their learning experiences? Were the devices themselves providing engagement? Did they enable interaction with self, others or the environment and did they support dialectic between the student and these entities?

The PDAs provide the students with learning experiences at two distinct levels: 1. The students were challenged to learn about the device itself and see how and when to use it so they could be more engaged in their lifelong learning – not just in their classroom learning, and 2. The students were challenged to use what they had learnt using the device as a mediator with their world. Could this device reveal or translate information for them in a different way to that provided via other tools or devices?

The researchers support the notion that teachers must be creative and challenge the learning styles and mores of their students. Teachers are challenged to create engaging learning environments and this should not involve adapting to the available technology but vice versa (Hoppe et. al 2003). So even though PDA ownership is small, if teachers are aware of their potential as learning tools, they can suggest, instruct and model good practice – and, as has already been suggested by these researchers, 'use students' mobile devices and social software applications, and challenge them to go beyond their use purely for social ends, and use them to be participative constructors of knowledge in engaging learning experiences' (Oliver & Goerke 2007).

Learning though disengagement

If convenience, connection and control are claimed to be the factors driving the Net Generation's take-up of information and communication technologies (Caruso, 2004), then this explains why the participants gave up on their PDAs which became inconvenient: '*We [three students] tried to use it in lectures for recording things but it didn't work well. It was good for recording five minute bits but it's not good like a MP3 player that I use for recording lectures*'; disconnected: '*I finally got the wireless internet working at a friend's house. It is very slow and probably not really worth the effort,*' and over which they had poor control: '*The stylus annoys me because it always needs to be taken out. I wish I could use my hand to touch the screen without ruining it,*' and another response*, 'the handwriting recognition doesn't work well – you have to revert to the [screen] keyboard every time. The best way of using it I think is to use that fold-out keyboard. I don't yet have one but I want one'.* Another aspect of 'control is 'creativity' as it was evident that these members of the net generation wanted to use tools that allowed them to generate their own unique version of information – and even of identity – but the device proved to be limited here also: '*I did take it with me [on site] but it wasn't useful. It was much easier to use conventional paper*'. The final disengaging factor was that the cost was prohibitive. Though these devices were given to them for a trial, the students saw the PDA as nonessential items: '*that's another thing: everything is too expensive for it. It's like having another computer. It's the same worry as having another laptop and losing it!*'

Learning to blog – or not to blog

The PDA project was used as a reason to introduce web-logging or blogging into the participants' course. The aim was to provide the opportunity for the research participants in Perth and those in Miri (Malaysia) to create and maintain a group blog where they could exchange thoughts about their experience in the project and communicate in whatever way they wished, and, as is the nature of blogging, invite responses from anyone in the blogoshpere. Most significantly, the aim was that the HP students could engage in mobile blogging – connecting and engaging with each other and the web whenever and wherever they wanted to. This desire to connect the project participants, was the impetus to extend the requirement to blog (via group blogging) to all the students in first year engineering by making blogging an assessment requirement in the communication skills unit they were all enrolled in.

The 2005 survey findings in this project had found that 70.2% had never engaged in blogging and this was similar to Kennedy et al. (2006) who found that 65.5% had never blogged. Even the follow-up survey of the new incoming students in 2007 failed to show a significant increase in blogging with only 29.8% of students stating that they had ever read or posted to a blog. Coupled with these findings was the fact that the wireless infrastructure failed to enable easy Internet connection so none of the participants attempted mobile blogging. The aims of the project to enable students to connect with their peers in another country via their mobile devices failed. These difficulties in achieving and maintaining any wireless internet access led to students using their laptops and desktops to connect with each other. However, even this was contrived and had no reason to exist apart from the assessment requirements. This overall reaction against blogging will be explored in a later paper.

Learning with, and in spite of, technical limitations

The already mentioned failure of the campus wireless network was unforeseen as was the fact that WebCT, this university's student learning system, could not be accessed via the mobile device. All of the students' units had components of their course in this system and students were required to access it very regularly. Such things as lecture notes, recorded lectures or discussion boards could not be used on the PDA and this was sees as a deficiency by the research group. The other issues (such as small screen and synchronisation issues) that relate to the limitations of mobile devices were named at various times by the participants but none of these alone were insurmountable.

However, the effectiveness of an mLearning experience is inextricably linked to the infrastructure into which it is introduced. Not only must the students, teachers and curriculum be ready to hold the technology, but without the essential technical support – in this case, a working wireless network and someone always on call to answer any question any time – the students chose the easiest option which was to leave the PDA in its cradle. Technical ICT support that is easily accessed and readily available must be provided to both teaching staff and students who are expected to use ICTs. The development of student and staff technoliteracy is essential in any successful collaborative learning using ICTs (Kimber, Pillay & Richards, 2007). For if the students are enabled and supported in how they use ICTs

in an educative environment, it is not only they who will develop their technoliteracy, but so, inevitably, will their teachers.

RESEARCH LIMITATIONS
The comparative empirical data was gathered from a small sample of students from a single discipline – engineering – therefore this constrains the generalizability of the findings. Another limitation of this study is that it only assessed the ICT behaviour of new university students over approximately 12 months. It would be helpful to conduct a longitudinal study to evaluate whether these same students change their ICT habits over the course of their whole degree and whether their behaviour can be linked to this early exposure to the PDAs. Even accounting for these limitations, students participating in this project provided valuable insights into current tertiary student digital behaviour.

CONCLUSION
It can be surmised that, for these students, the device was judged to be an accessory and not an essential – or even highly desirable – component of their 'digital backpack'. Labelling the PDA as an accessory is not in itself a comment about its deficiencies. As was noted by Jones et al. (2006) the 'coolness' of a mobile device is a motivating factor for using it. Young people like to accessorise. Jones et al. also noted more generally that 'affective factors play a strong role (both positive and negative) in harnessing technology for learning'. These attitudes were evident in the interview responses – and in the interactions observed between the participants at the group meetings; from observing the nods and other indications of initial consensus among the students that a 'new toy' is fun, to comments from some group members that they would be changing how they used the device based on ideas and feedback from others in the group.

Student participants were grateful for the chance to have and explore a device none of them had ever owned before. However, after their initial enthusiasm, the participants appeared to minimise the potential of the device because of the various technical inconveniences that thwarted their efforts. These devices could be labelled as 'first generation' PDAs and thus the problems were to be expected. Changes in the students' interactions over the time of the project could not be directly linked to the device, but as one student said *I got to know more people and learn more stuff about blogging.'* This project's findings concur with those of Jones et al. (2004) who found that PDAs were used primarily as 'personal technology' rather than as 'educational technology' and in this environment, the difference between the two spheres was confirmed in the student behaviour.

Finally, the efficacy of a PDA in such an unstructured learning environment is highly dependent on the motivations of the individual student. Unless there is support and explicit modelling of how to use the PDA, it will remain a nonessential device. Though this project group was unable to arrive at the 'tipping point' referred to by Cobcroft et al. (2006) where a clear decision had to be made as to whether to encourage and invest in mobile technology (specifically here, for engineering students at Curtin), it can be concluded that further exploration of mobile devices within this discipline area with full support from the university, should be encouraged. Mobile devices that initially, to the digital immigrant, may seem more like a social or organisational tool can also clearly be helpful learning tools, adding significant value to the educative experience of our students.

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USING MOBILE TECHNOLOGIES FOR OPEN AND DISTANCE LEARNING COMMUNITY DEVELOPMENT

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ABSTRACT

This paper considers how mobile technologies are being used to promote community development, peer support and engagement in university sports websites and how such technologies are being used, or could be used, in an academic context. Although the term is as old as civilisation itself, for the purposes of this paper clanning is defined as a sociological phenomenon observed on the Internet by futurist Faith Popcorn that occurs wherever people gather virtually to discuss and promote common feelings, ideas or ideals. Clanning may lead to benefits such as increased enrolments, increased motivation and reduced stress. Although clanning is most apparent in team sports, clanning is also seen amongst those using mobile technologies, whether acquiring cachet from their area code, downloading the latest ring tone and playing it in unison in the stadium or showing their colours with an appropriate wallpaper or ring tone. Sports mobile portals, websites or parts of websites designed for access via mobile phones are compared with education portals containing sector specific resources and services. The portals are examined for exemplars of mobile technologies and techniques suitable for the promotion of clanning in open and distance education.

Author Keywords
clanning, mobile portals, peer support

INTRODUCTION

Although the term is as old as civilization itself, for the purposes of this paper clanning is a sociological phenomenon observed on the Internet and defined by futurist Faith Popcorn (2007) as "belonging to a group that represents common feelings, causes or ideals; validating one's own belief system". Popcorn sees the trend as a response to the increasingly impersonal nature of modern life, no more impersonal than on the Internet. Internet gamers also claim the term as their own. Clans may often contain many sub-levels with which the individual can identify or aspire to. Internet gaming clans for example are subdivided into guilds, which compete in tournaments. The centuries old New Zealand Maori social structure (Britannica 2007) of iwi (tribe), hapu (sub-tribe and landowner) and whanau (extended family) is an example of a well-ordered clan system and though based on extended family ties shows the same sort of hierarchy as those in gaming sites. The ancient clans of Scotland are another example of clanning being around for some time. The author argues that instead of being a new phenomenon born of the Internet, clanning is really an ancient phenomenon and more an innate response to gather with those of like mind than a response the Internet. Clanning is viewed as a powerful binding force, on the macro-level binding the individual to the institution, and on the micro-level binding together members of a virtual study team. The trust necessary for easy communication and interdependent peer support is established faster if the individuals involved already feel that they and the others in the group are already part of a larger whole. Such oneness or belongingness is flagged by means of the visual and auditory symbols described later. The author has previously searched for clanning promoting exemplars with respect to peer support, comparing the provision in team sports and academic websites. With mobile learning hesitantly appearing in New Zealand, the author continues the quest for exemplars of clanning for peer support, this time in the mobile online environment.

Clanning 101

Team sports, stands out as the best examples of clanning in action. Football and rugby, two of the oldest and most popular of team sports have well developed clanning and promote that clanning electronically through their websites. So to see exemplars of the use of techniques to promote clanning via mobile websites, football and rugby websites would seem to be a good place to seek some answers. Some of the requisites of clanning will be examined and team sport mobile websites will be compared with those of Universities (College and University Home Pages, 2007) in the United Kingdom, New Zealand and the United States to see if and how the necessary tools for mobile clanning are provided.

A superficial examination of any University website shows that University colours are as ubiquitous as Team colours. There are as many University coats of arms as there are Team insignia. Fraternity songs (Sigma Phi Epsilon, 2007) and alma mater songs appear as often as Team chants. Rowing or football competitions between rival Universities are as common as long held grudge matches between competing sports teams in neighbouring cities or countries. Memorabilia, scarves, mugs, sweatshirts in

the "team" colours abounds in the websites of both Universities and team sports. There are so many similarities between clanning in both University and team sports websites, but the question is - have sporting websites moved ahead in the area of clanning through mobile technology, leaving University websites tethered to their desktops? Should we be looking at team sport websites to see the future of mobile tertiary education?

In the sporting websites, opportunities for gathering information about the team such as statistics, membership of the team, and team chants are complimented by sophisticated facilities allowing fans to receive pushed information via SMS about anything from the latest goal scored in real time to future ticket availability. Fans can download songs associated with the team; team chants and even show their identification with the team clan by purchasing ringtones of the crowd's roar and mobile wallpaper related to the team insignia or stadium. Some of these items are only available within the stadium and for obvious financial reasons fans are encouraged to show their membership of the clan by playing their tunes in unison. Such downloads, riding on the back of the Crazy Frog ringtone (BBC News, 2005) are recorded in the UK Singles Charts displayed prominently within the stadium. Fans can text chat with the team members and send SMS to them. They can share their enthusiasm, and challenge other fans in tournaments and quizzes to demonstrate the extent of their knowledge of the team. These competitions echo the tournaments of the Internet gamers and the rowing competitions of Oxford and Cambridge Universities. These exciting facilities are swathed in a glittering wrapper of moving graphics and sound. By allowing the clan member to identify with and be identified with the clan the feeling of belonging is intensified. This brings repeat business and a lifelong association with the team. A comparison of the home pages of the New Zealand All Blacks rugby team (2007) and UK Liverpool Football Club (2007), two teams with a fanatical fan base, with those of Cambridge University (2007) and the University of Liverpool (2007) in the UK, the University of Otago (2007) in New Zealand, and a number of US Universities show clear differences in the levels of excitement and mobile communication facilities available at their respective sites. This is covered later.

CLANNING AND MOTIVATION
Hunt (2000) describes an example of how clanning aids motivation.

"Every night Mary Ann Woirhaye does the unthinkable. She sets her alarm for 4:30 a.m. because every morning she gets up and walks three miles while the rest of the world sleeps. How has Mary Ann managed to stick with this early morning fitness routine for more than three years? Simple. She knows that someone is waiting for her. Two people have made a commitment to show up. The secret of Mary Ann's success is that she chooses to be accountable, not only to herself but to another person who shares her desire to become physically fit. And how is this working out? Extremely well, she reports. The faster she and her buddy walk the louder they talk. And laugh. They even argue from time to time. They share their lives and brainstorm their dreams. They get so involved they don't notice the miles clicking away. The deep friendship that has resulted from this daily event not only makes the task possible, it makes it enjoyable."

Students often study together to their mutual benefit in both contact and distance education. In an article on study buddies in "Connections" the official newsletter for students of The Open Polytechnic of New Zealand (2001) students are quoted saying:

"We just clicked", says Leigh-Ann. "We both had a goal that we wanted and were prepared to put our heads down and get on with the job."

CLANNING AND STRESS
Roizen (1999) suggests that joining a group reduces stress. The importance of reducing stress during periods of intensive study and especially just before exam time is obvious. Dehne (2000) in an article on the future of private colleges makes the following observation:

"Many colleges are noticing the increased interest in theme houses — facilities where students choose to live together to speak a language, talk about science and technology, or provide community service. A college itself can be a "clanning" experience. Small colleges devoted to the environment, great books or a conservative Christian viewpoint are essentially "clanning." Of course, a reputation for serving a certain

"clan" can be risky for a college that is already homogenous. If the concept of affinity groups continues and grows, it is possible that only students with similar interests will attend some small college."

Dehne clearly sees the importance of clanning in small colleges; so can we extend this into the University?

Oxford and Cambridge Universities are organised as a series of colleges, within a larger entity, with different colleges specialising in specific subjects or leisure interests. American fraternities are an excellent example of clanning, whereby new members are invited to join, or apply to join fraternity houses with particular interests or allegiances within the larger University. So clanning has been entrenched within the larger contact Universities for hundreds of years.

A BRIEF SURVEY OF ACADEMIC MOBILE CLANNING
Contact Universities often place much of the burden for clanning on the Student Union. Their support for the Union is often merely financial. Are they also ignoring the importance of clanning via mobile technology within the broader University? Clanning is as important for prospective students as for Alumni. Distance institutions in particular must have regard for the clanning needs of their students, over and above the provision of summer schools or learning management systems. Failure to provide for clanning may leave learners feeling isolated and disconnected (Liu et al, 2007). These feelings of isolation and the lack of community could result in low retention rates (Eastmond, 1995).

An examination of the website of the Open University (2007) of the UK showed no opportunity to SMS for information or receive information by SMS regarding the University. There was no mobile portal. In the Alumni area mobile number was not requested. The OU Life Screensaver acts as an RSS feed updating students with information every 20 minutes via the Internet and is paid for by advertising. Just a small step to mobile wallpaper, ringtones and pushed text?

At the University of Liverpool (2007) there was no mobile portal or option to send or receive SMS information. Alumni complete a form to request to be kept in touch with others. An email address is requested but is not a required field. There is an opportunity to enter an alternative phone number, but a mobile phone number is not specifically requested. The University offers dial up access and suggests users could use their mobile phone as a modem to access their services when off campus and away from home. Interestingly access from a home desktop computer is viewed as mobile computing. Several mobile devices are supported by the University Computer Services. Advice is provided about Bluetooth.

At the University of Otago (2007) in New Zealand there was no mobile portal. The Alumni form does not specifically mention a mobile number and does not offer an option to enter an alternative number. Conversely staff are encouraged to use mobile phones by having their plan under the Corporate plan. Perversely students are charged to use the remote access to the University network and voicemail is optional. A wireless LAN (802.11b/g) has been deployed. Streaming media services are available.

The University of Waikato (2007) has no mobile portal and no way to send or receive SMS. A mobile number is not requested. The University links its website to the New Zealand Alumni Associations in Thailand and China. The University has several ways of allowing students to show their clan affiliation with the University including a University signet ring and Visa card.

Christchurch Polytechnic Institute of Technology (2006) partnered with a major telecommunication company to use SMS to accept entries for a competition. This could have provided an excellent mobile database for later use. There is no mobile portal, or any way to send or receive SMS. A mobile phone number is however specifically and prominently requested on the online enquiry form.

In none of the sites were there any opportunities to do what could be termed "play before you pay" that might encourage prospective students to visit the institution's site and connect with those already studying. Such pro-clanning strategies could pay dividends in terms of student enrolments and assist in pedagogical terms by creating understanding of online culture and behaviour whilst also establishing relationships before they attend either virtually or in real life. Online discussions on subjects taught at the institution are little different from the free public seminars at contact institutions. More social online discussions around hobbies would be equivalent to an online student orientation.

We need to turn to the United States to see examples of the embedding of team sports clanning within the University website. Since 2001 the University of Miami (2007) appears to have understood the clanning power of sports, with an athletics link to the Miami Hurricanes site, which sports sales of ring tones, wallpapers and alerts. A link back to the University is provided on the Hurricanes website along with a glowing testimonial. There are other links within both sites providing channels whereby a football fan can suddenly find him or herself reading about the local University. Florida State University (2007) clans with the Seminoles and includes a brief promotional movie talking about the university while showing footage of swimming, football and all things non-academic. The University has also adopted the model for their "Everything FSU" website. Interestingly this website does not link via the red colour of the Seminoles as the main site does, apart from the text colour. Instead the green of the Seminoles site dominates. At Washington University in St. Louis (2007) advice is provided on accessing email via a mobile device, though SMS or pushed SMS is not available. Wireless access points are explained and appear to be ubiquitous using 802.11b WiFi. The University links to Bear Sports via an Athletics link. Bear Sports does not appear to have the same mobile facilities found on other sports sites. The Miami University (2007) website is linked directly to the Miami Redhawks site with a prominent Redhawks link, perhaps expressing the greater importance placed upon this association. As would be expected there is a link to a site providing wireless alerts, ringtones and wallpapers via CSTV. UCLA (2007) links to a generalised "Happenings" page with links to the UCLA Bruins plus other sports, arts and lectures. The links to the Bruins appears to be less pronounced than in 2001. What appears to have happened is that the basis for clanning has been broadened and now includes things other than football. By supporting a more diverse range of sub-clans the University stands to draw in a broader range of people. The University provides RSS links from the main site regarding Happenings at the University ranging from ballet to lectures. Students can also add reminders to their calendar. Predictably the Bruins site has a wireless page that pushes scores and headlines to mobiles, but not by email or to palm pilots. Live audio and video available though it would appear this is only available to PC.

By supporting a team of heroes that young people can identify with the Universities encourage clanning between city and university, and develop a feeling of local connection to the University. Young people will already feel an affiliation to the University before they enrol and continue that association later through the sports team or Alumni associations.

CLANNING IN DSTANCE EDUCATION
Most educational establishments, both contact and distance providers, have websites. Increasing numbers of those Universities also have courses using electronic delivery systems such as Blackboard (2007). The Blackboard delivery system has a facility for the creation of online components for clubs and other organizations with the same features as the course delivery system. This allows the club members to discuss issues both synchronously and asynchronously and organise various events through the system. This supports the development of social groups within courses, promoting clanning and stimulating peer support.

The author has used regional study groups and national-ethnic study groups within his courses and this has often stimulated peer interaction, if only due to the reduction in group sizes. Therefore clanning is apparent even via distance education and exploiting the motivational and stress reducing properties of this experience. Perhaps distance education should be renamed "we-education", due to the many one-to-one relationships and small groups that spring up naturally within a suitably moderated online environment both between students, and between students and tutor.

Where to from here?
The University of Wales (2007) offers the opportunity for students and alumni alike to identify with the institutional clan in all future on-line communication, by means of an academic e-mail address for life e.g. username@univ.bangor.ac.uk. Harvard (2007) also provides e-mail forwarding and in addition extensive communication facilities. The power of such signs of affiliation should not be underestimated. What more powerful status symbol than John.Smith@harvardMBA.com as a permanent electronic badge of status and clan affiliation to be displayed with pride on a business card? With the kudos of area codes now apparent will organisation mobile codes connected to Universities and prestigious organisations be far away, e.g. Harvard 12345?

Clanning via mobile communities offers the opportunity of attracting new students to online or contact courses by changing the University's website from a closed information source, into a portal with a strong community element that is open to all (Looney 2000) and accessible from the University's home page. By supporting groups of people currently not enrolled on University courses, who have similar interests in computing, rugby, classical music, arts or any other interest and allowing them to discuss their special interests in the University's mobile communities, educational establishments could attract potential students on the basis of the quality of the community support they provide. At first glance, this might appear to be gross commercialisation of education, a spider's web or fishing net, but there is little difference between such virtual community groups and the rowing and rugby clubs of Cambridge and Oxford, or of the commercial sponsorship seen at many team sport events. Should this way of attracting students be widely adopted, competition between institutions to offer better communities would be fierce. To differentiate themselves from the other institutions offering the same sort of communities, Universities might invite prestigious visitors or sporting heroes to participate in the discussions in the various communities. Once again, there is little difference between this and the University visits of celebrities such as Michael Jackson to the Oxford Union. Competitions between similar virtual communities at different Universities reminiscent of the rowing contests of Oxford and Cambridge might develop. Just as the sports teams draw young people to the contact University, so the mobile communities could help connect potential students to the distance institution. People are often drawn to distance education because of the anonymity it affords and are likely to be less wary of mobile communities unrelated to academic study. Some may lack the confidence to take part in tertiary education. A friendly supportive community that is always just a SMS away is just the sort of atmosphere to establish confidence and do the necessary groundwork for understanding more complex ideas later. As with the clubs in schools and colleges around the world it is the participation of friendly experts in these communities that allows students to acquire the skills to move to the next level. There is no reason to suppose that reasoning and discussion skills should be any more difficult skills to acquire through a mobile community than through a contact group.

CONCLUSION
Future mobile educational portals should consider offering free and open Internet community building opportunities, perhaps linked to team sports initially, but diversifying to a wide range of other special interest communities. By offering opportunities to form relationships on the site, institutions are likely to gain a growing number of potential students with specific interests that can be targeted with courses of particular interest to them, in a medium that they are already familiar with. Opportunities exist to allow potential students to gather at the doors of the distance institution, to sustain them with strong supportive relationships throughout their University career and maintain those relationships, both with fellow students and the University throughout their working life. Exemplars of techniques that could be used to promote clanning can be found on any team sport website. The author encourages academics and registrars alike to leave their "dreaming spires" and visit the sports field and realise that clanning is a means of interesting the majority of the population who never undertake tertiary study. The author has no plans to carry out a more extensive study of this area but believes that further research needs to be carried out with respect to the relationship of mobile clanning to distance and contact university community building.

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M-LEARNING: THE FIRST PIECE IN THE DISTANCE LEARNING JIGSAW?

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ABSTRACT

This article is intended to contribute to the understanding of the role of m-learning in developing effective distance education models, particularly for the benefit of those living and working in developing countries.

It tells the story of the developments, over the last decade, within a global distance learning programme. It focuses on the ways pedagogic innovation and use of new technologies has influenced the teaching and learning strategies. The introduction and impact of e-learning applications is outlined. Emerging challenges faced, particularly by students in developing countries, are highlighted.

Since 2005, the programme has piloted the use of latest mobile technologies with students based in the 'Southern African Development Community' region. The pilot project explores how m-learning can be used to enhance existing paper based and e-learning approaches. There is discussion of the progress being made in addressing access issues and making appropriate use of mobile technologies in the design of learning resources, and in the tutoring process. The article concludes by exploring the question whether mobile technologies provide a final piece in the jigsaw to maximise the potential of distance learning, or a starting point for development of a new educational model responding to the needs of mobile learners.

Author Keywords

Distance Mobile Africa Learning ICT4D Global Postgraduate E-Learning Print Multimedia Phone Technology Pedagogy Developing Development Digital Divide Pilot Case Study First Mile

INTRODUCTION

This article focuses on the story of a Distance Learning Programme (DLP)[2] which had its origins in the 1980s. Since that time it has offered postgraduate degrees. It has over 1,300 registered students studying in more than 100 countries, so the programme can claim to be truly global. It offers MSc, Postgraduate Diplomas and Certificates, and runs short courses in three major thematic areas: 'Sustainability and Development', 'Environment and Biodiversity' and 'Applied Economics and Business'.

Most DLP students are mid career and working full-time, and a significant proportion are based in developing countries, with over four hundred students currently based in Africa.

Until the mid-1990s all students received printed study packs, containing a study guide, text books, and bound volumes of copyright cleared readings. Students had the option to submit two 'Tutor Marked Assignments' (TMAs) by airmail each year and receive feedback from their tutor.

The advent of email and the Internet brought rapid changes. Whilst the DLP had always sought to focus on pedagogy as the driver of innovation, those with appropriate technology and connectivity had often benefited most from the significant innovations in relation to tutoring and design of courseware, and in the ways in which they communicate with the programme.

This article explores the changes in the DLP's distance learning provision that have taken place over the last ten years. It reflects on both the benefits and the new challenges that have arisen, for providing an equivalent high quality of education to students irrespective of their location. It focuses in particular on a recent two year mobile learning project titled 'Developing an educational model for delivery and support of postgraduate distance learning in Southern Africa that incorporates m-learning', funded by the University of London Centre for Distance Education (http://www.cde.london.ac.uk/), which commenced in 2005. In the context of this project m-learning is seen as offering potential for enhancing the emerging

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[2] The DLP was part of Imperial College London until 1st August 2007 when it was transferred to the School of Oriental and African Studies (SOAS) and became part of the newly formed Centre for Development Environment and Policy (CeDEP, www.soas.ac.uk/cedep). Within SOAS it now forms part of the largest postgraduate distance learning programme within the University of London.

blend of traditional and e-learning models, and providing a model that could eventually provide access for all the DLP's students to a similar range of tutorial support and educational resources.

The article concludes with a discussion of whether m-learning should be viewed as an enhancement to current models for distance learning, or whether it could turn out to be an effective starting point for design of a more radical provision of education to mobile learners studying at a distance. A key question emerges - is m-learning the last piece of the jigsaw or the first ?
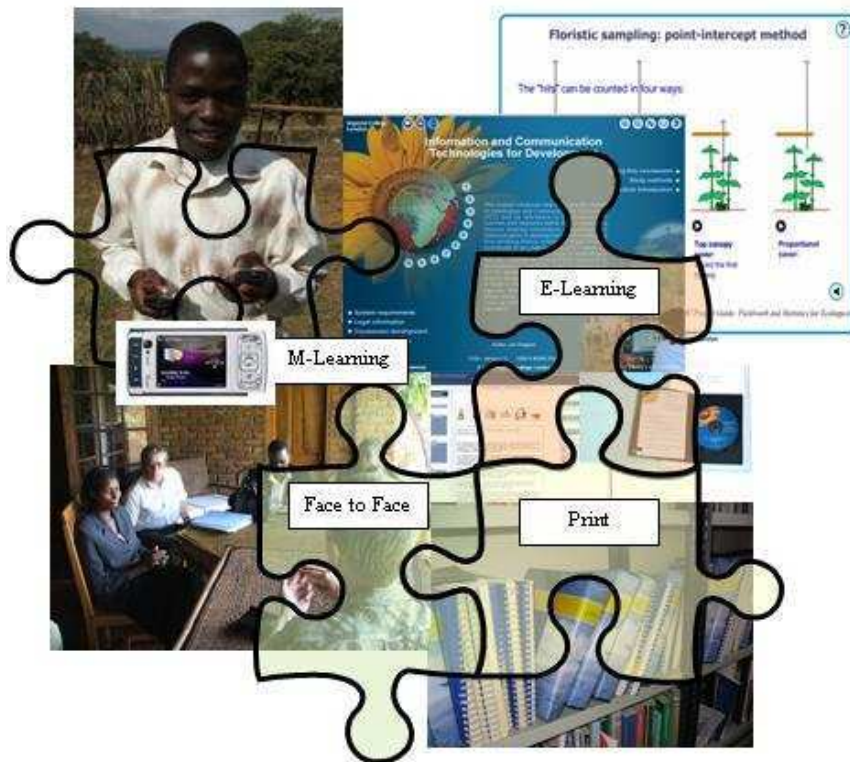
EVOLUTION OF THE DLP

From its outset the DLP focussed on the problems and challenges of developing countries, and had an educational agenda, set out in a stated mission:

"to make a contribution to human well-being worldwide by providing high quality teaching and learning resources to people from around the globe, and equipping them with the necessary skills and knowledge to:

- improve government policies
- make businesses and voluntary organisations more effective
- enhance the management of natural resources"

It is important to the later discussion of the role of m-learning, to understand the rather unique nature of the educational programme rooted in its strong social objectives and desire to 'make a difference'. Likewise from its early days in the 1980s, the programme has sought to innovate through pedagogically driven use of new technologies, and promote access to the courses through appropriate use of technology and international collaboration. This entailed a focus on educational research, and emergence of a pedagogic model that sought to engage students in learning from their peers within the DLPs global student community, and encourage them to take a self directed route through their studies, rather than relying too much on expert instructors.

At the outset considerable attention was given to authoring printed study guides, where the author in effect provided the 'tutors voice' and facilitated the learning process, by guiding the student through

accompanying volumes of key reading materials. For some course modules audio and video cassettes were also provided.

The DLP started to invest significantly in learning technology and instructional design in the 1990s, and since that time a lot of progress has been made in introducing e-learning applications and use of electronic communication to enhance the traditional print based materials. In order to provide a context or understanding the issues involved in exploring m-learning, the key developments are briefly described and depicted in the sub-sections that follow:

Instructional Design and Content Authoring

Interactive study guides produced on CDs have been developed for many of the DLPs course modules. The content is designed as HTML pages which can be viewed in a web browser. This facilitated ease of use, since many students were becoming familiar with use of freely available web browser software. In this form content could also eventually be published online, but the expectation was that students would have access to a computer with a CD-ROM drive but not necessarily have Internet access. CD based courseware and CD's containing resources available for download from the DLPs online learning environment are distributed to students at the start of the year.

Figure 1. Print and CD based study guides

Figure 2. CD Study Guide Homepage Example

The CDs do not currently include a lot of multimedia content, but do have interactive self assessment questions, animations and search facilities. All content can also be printed, as 'pdf' file versions of the module content are provided on the CD.

The development of CD based courseware acted as a catalyst for producing a more flexible authoring model, based broadly around the concept of reusable learning objects (RLOs). The DLP also became involved in collaborative initiatives that will develop this model further, through creation and sharing of Open Educational Resources (OERs).

Practical issues that have arisen, through the introduction of the CD version of the study guide, relate to (i) access to a computer and printer, (ii) issues relating to studying on screen and (iii) portability and usability of study materials when a student is travelling. This latter point also applies to travelling with bulky sets of printed materials.

Tutoring and Peer Group Learning

The possibility of tutoring online, and students interacting with peers, led to the development of an online learning environment (OLE). Over the years the design of the OLE has been improved based on student feedback, and it is used primarily for discussions, asking for academic help, and for sharing learning and administrative resources.

This e-learning based approach provides significant access to tutoring to roughly half the student body. However nearly all students have email, so tutors produce monthly e-digests, so that those with limited internet connectivity can be informed about online discussions, and feed in their questions and ideas.

The role of the distance learning tutor has undergone a major change. It has moved from being purely a task of providing TMA feedback, to being a front line activity, through which the DLP seeks to provide good academic support to all students. The voice of the tutor that previously had to be found within the study guide is now more directly accessible.

Figure 3. Screenshot of Online Learning Environment (OLE) Home page

Once again however, the introduction of an e-learning based approach has brought benefits and challenges. Many students in developing countries cannot participate fully in the OLE discussions, due to limited access to computers and the Internet. The e-digests have partially addressed this problem, but students who live in villages often have to travel a long way to read emails in a cybercafé, and when students go for field work they are often unable to access email.

Face to face tutoring is in many ways the gold standard, and whilst the DLP sought to run some in-country tutorials it is a very expensive model to operate, and due to student work commitments or the distance involved in travelling to a centre, participation is often lower than envisaged, resulting in advance preparation by a tutor being wasted.

A further access issue relates to online journals. Through an 'athens' account, registered students can access journals and articles online, and this supports study and in particular preparation of a research report. Once again those students in countries where this may be most valuable, are the least likely to be able to access the service.

Communication and Support

It will already be evident that the last decade has seen a revolution in the ways in which the DLP can communicate with and support students.

TMAs and correspondence have rapidly migrated from airmail, to FAX, followed by email and web based notices (on the OLE). Over 95% of students have email addresses, and it is increasingly evident that a similar proportion are likely to have mobile phones with access to voice and text (SMS) services.

All these communication options continue to be supported, though use of email now dominates the communication, and online support (technical and administrative) deals with many standard and individual queries.

Figure 4. Students participating in the mobile learning project, pictured at a workshop in Malawi, May 2007

Rapid and reliable communication with students has become a major requirement for a successful distance learning programme. This affects not only administration, but earlier studies (for example by the University of Pretoria) have also shown how this can enhance student commitment; the timeliness of submission of assignments; and provide an improvement in overall student progression rates. The current communication options favour those with the best connectivity, and those students with regular email access, Broadband internet, use of Voice over Internet Protocol (VoIP) applications like skype, are the most advantaged.

THE MOBILE LEARNING PROJECT

Project Overview

The introduction of m-learning within a programme like the DLP has to be understood in the context of:

- organisational objectives
- pedagogical objectives
- the need to address problems faced in achieving these objectives

Technology affects access and pedagogy, and depending on its affordances can offer new approaches, solutions to problems, and can also introduce new challenges. Chronologically m-learning has come after other e-learning applications and we have taken time to provide an understanding of what has already happened. Rightly or wrongly in the project that the DLP embarked upon, m-learning has been perceived as an 'add-on' that can enhance access and also potentially lead to pedagogical improvements in the following three main areas:

- providing alternative or replacement of content, where a concept could be most helpfully explained through audio-visual media rather than text
- improving support from tutors, through text messaging, and also through multimedia versions of the text based e-digests and interaction relating to learning activities
- redesign of activities, so that the essay based TMA model is turned into a series of tasks that can utilise the mobile device to capture and share audio visual material, and interact with the tutor and fellow students. A small portfolio with a written component is submitted to the tutor for feedback

This starting assumption relating to m-learning as an enhancement will be discussed further in the later sections.

The project commenced in 2005, and focussed on the needs of over one hundred of the DLPs students who are based in the Southern African Development Community (SADC) region. A baseline survey of these students was carried out, that revealed surprisingly high access to computers and Internet though this was mainly in the workplace. Most students considered themselves ICT literate, made good use of the course CD-ROMs and e-digests, reasonable use of the OLE, and had their own mobile phone. Interestingly the majority were also highly mobile, and often spent in the region of three months each year out of their offices doing field work. During these periods their study was problematic, and whilst a significant proportion is making good progress, concerns arose regarding overall progression and exam performance. The DLP began to invest in addressing this problem, and in country tutorials and regional workshops were organised. These were partially successful, though in some countries attendance was disappointing.

In February 2006, a visit was made to Malawi and Tanzania where meetings took place with students and cellphone network service providers. Existing projects and relevant literature was reviewed, and this all suggested that the rapid diffusion of mobile phones and the evident investment in GPRS and 3G services could lead to some interesting new medium term options for support and instructional design. Four students became involved in the process of assessing different mobile technologies which led to the purchase of Nokia N70 phones for the students to test. At this stage we remained primarily interested in feasibility, and the students rapidly proved to us that they could use the still and video camera and recording features of the phone. Little support was needed, and files were transferred back and forth with the students, through a transfer and synchronisation process using PCs and email communication. This intermediate step is not considered part of a long term solution, but is necessary until such time as the GPRS/3G services become more widespread and the transfer of data is less costly.

It is perhaps misleading to refer to equipment like the N70 as 'a phone' with a rich set of applications and features. In reality it is a small handheld computer, camera, sound recorder, music player, radio, which also has voice and text communication features. It does however have the screen and keyboard limitations associated with most mobile phones!

Authors and tutors from two course modules – 'Rural Development' and 'ICT for Development' – now became involved, and started to look at the potential of the N70 for testing the three main areas for pedagogic innovation, identified earlier. The nature of the subject matter suggested different approaches for the two modules.

- The 'Rural Development' module had an inherent narrative, and the author decided to record an audio version of a unit. He also developed 'quick quizes' designed to test and reinforce basic facts, and that could make use of convenient 'learning moments' when a student wanted to spend a brief time using the mobile device to support their study. Videos were identified and converted for watching on the mobile device.

- By contrast the 'ICT for Development' module had more interactive and technical content, and the instructional designer decided to focus on video and audio interviews, with the author and other specialists. Short case study videos were also sourced and converted for display on the mobile device. Most significantly, alternative versions of the essay based TMAs were designed. These encouraged students to use the device to interview and capture data and share this with their tutor and fellow students, and become more directly involved in creating resources that supported their study.

In 2007, ten students from each of the two course modules were supplied with N70 handsets, together with the materials that had been developed, which were stored on external 1Gb 'mini SD' card. Ten students were based in the SADC region, and ten more were distributed across a range of developing countries. The N70 handset was supplied at this stage for two main reasons:

- We wanted to assess the educational content, and not be distracted by technical aspects of a diverse set of mobile devices with different specifications

- We wanted to learn lessons that would inform programme design for the future, and therefore needed to be doing the pilot testing on equipment with a specification that was likely to be in more common use in 2009.

Lessons Learned

In May 2007, a follow up visit was made to Malawi, to meet the four students who had become core team members and providing ongoing insights, feedback and ideas. The advanced use they were making of the N70 was evident, with some using the office viewer software and scheduling applications, and also finding the camera and audio capture functionality useful in their work and study. Four important trends were noted:

1. Mobile phone coverage was rapidly extending to rural areas
2. Cost of the handsets and external storage cards was reducing significantly, and in some countries the cost of the N70 was approximately half the price compared to one year earlier
3. The functionality and usability of new models of handset was increasing rapidly
4. Student skills in the use of mobile technologies were developing

During this visit, we also met students who had received the new learning materials. There was obvious enthusiasm for the move towards more multimedia content, and the portability of the handset was seen as very useful. Students commented that the phone would be the 'last thing they would leave behind when going on field visits'. It was clearly a personal device, and having a phone which was more like a tiny computer that could support their study was certainly something that was making a significant difference for them.

All the students who were issued with the new course materials and N70 handsets had been asked to send in short videos and audios commenting on their experience, and many commented on the value of seeing and hearing their tutor, and felt that this made their study experience more personal and increased their commitment and the likelihood of them submitting assignments.

A fuller evaluation will take place at the end of the study year in October 2007, but at this point the main lessons appear to be:

- It is well worth planning and preparing now for a wider implementation of m-learning
- The nature of the subject matter is important for determining where m-learning can best add value to existing printed and e-learning resources
- Increased emphasis on design of multimedia learning resources is needed, and this will bring with it greater support for different learning styles
- A really effective scaling up of a model that promotes file sharing will depend on more widespread and affordable GPRS or 3G service provision
- An environment which supports file sharing, can lead to pedagogical innovation, that would enable students to share files and contribute to the DLPs global learning community as authors of learning resources
- The immediacy of communication that mobile devices offer, will likely lead to pressure to further adjust the tutoring model. Whilst there would be some obvious benefits the cost implications and time commitment involved will need to be carefully assessed.

THE CONTRIBUTION OF M-LEARNING
Changing the model for distance learning – relevant trends

The technology aspect of the project outlined has focussed on the potential offered by what may be termed a 2nd/3rd generation mobile device, in the development of a distance learning programme. The multifunctional nature of this technology, which can support web browsing, and multimedia applications provides great potential for distance learning. Reference has already been made to ways in which the pilot project has begun to explore use of the audio and video capture functionality.

Whilst they have not been specifically tested in this pilot project, other trends that make use of the devices capability to connect to web applications and online content repositories, are likely in the

medium to long term to be of equal or maybe even greater significance. In particular the emergence of social software applications that network communities and interest groups (making use of blogs, wikis, podcasts), which will soon feature very strongly on mobile devices, have the power to impact upon and transform the design or learning resources and environments. Equally the move towards greater collaboration in the creation and sharing of educational content, as evidenced by the creative commons licensing approach and OER movement will impact upon the design of learning materials.

The diagram shown in Figure 5 that follows attempts to capture some of the components that would need to be considered in a learning environment that supports the mobile user.

The first or last piece in a jigsaw?

The path we have described in this article followed the introduction of e-learning approaches and most recently an investigation of what m-learning can add by way of further enhancement. As soon as this path was embarked upon, an access problem, typical of the so-called 'digital divide' and referred to in the telecommunications sector as a 'last mile' problem was in effect introduced. Those with access to PCs, the Internet, phones and good electricity started to have better access than other students to some of the DLP's services. Along the way, the balance has been redressed partially by specific attempts to help those with constraints introduced by the technology platform through provision of CDs, e-digests and continued support for all communication options. Mobile technologies are by no means ubiquitous in the developing world, but over time they appear to offer the best solution to addressing this last mile problem more comprehensively.
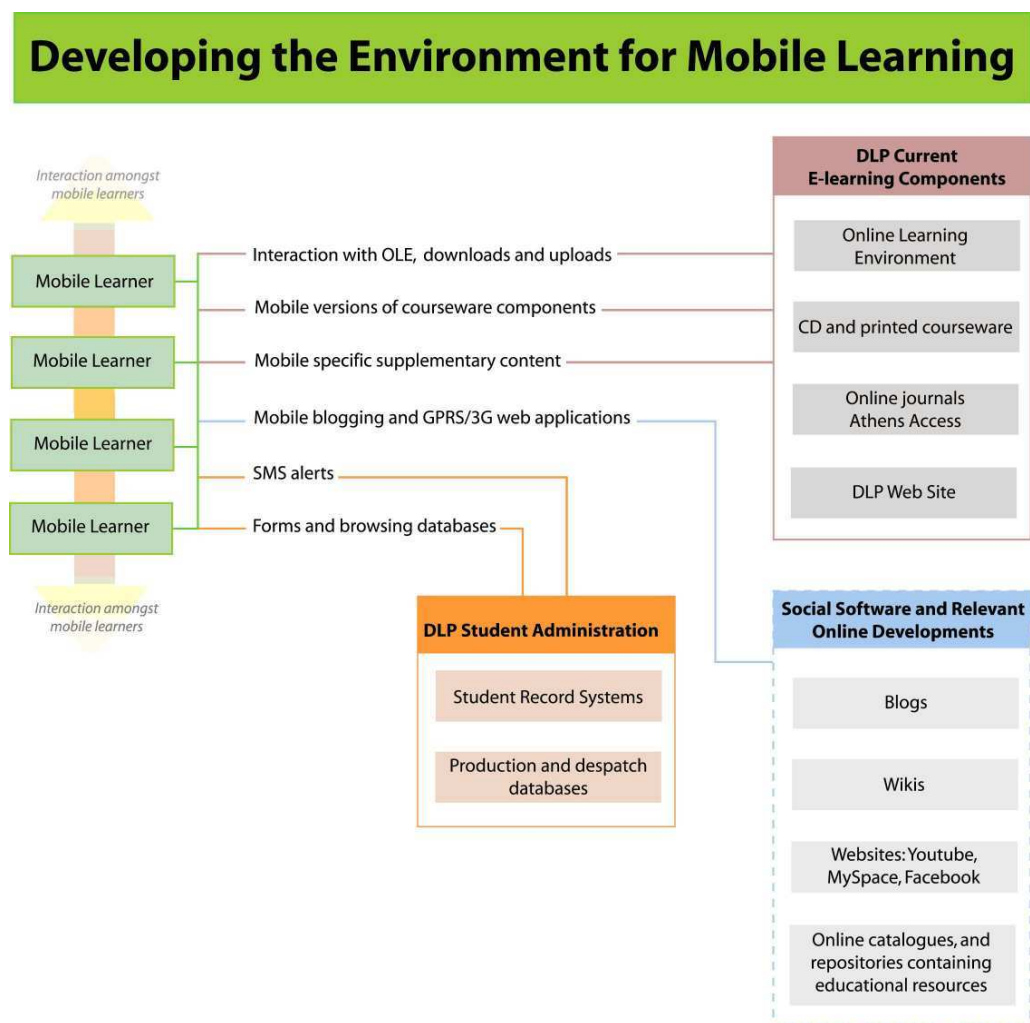
Figure 5. An overview of a Mobile Learning Environment

It is interesting to refer at this point to a broader range of debate regarding paradigms and theory, derived from the development sector and in particular the ICT4D and 'Communication for Development' work. Within the context of rural development Robert Chambers (1984) advocates the need to put the farmer first, and for the researcher to serve the needs of the farmer rather than taking the role of technology transfer expert delivering solutions. In his view this requires a new kind of professional development worker who facilitates learning. Don Snowden, a pioneer in the field of communications for development, who did a lot of work on use of video in rural areas of Canada, turned the concept of the 'last mile' on its head, and just prior to his death in 1984, he wrote a paper suggesting an empowered approach that sees the connection with the community as the 'first mile' and the most one to focus on. His work was articulated further by Don Richardson (1998). What does this mean for the DLP, and for distance education ? At this point it is worth recalling the work of Paulo Freire (1981) and his ideas relating to the 'pedagogy of the oppressed'. Here too, we see an emphasis that suggests that education should build up from empowered communities of learners who articulate their own needs and solutions, rather than rely on what experts seek to supply.

M-learning offers the potential to look at a design model for distance learning that starts with the first mile. As connectivity improves the mobile learner becomes empowered to
- take their own responsibility for learning anywhere and anytime
- place demands on the distance learning supplier
- interact with and learn from fellow students, tutors and experts globally
- share and exchange multimedia digital files with ease across different learning communities
- access formal and informal learning environments and social software
- engage in the process of creating learning resources
- make use of personalised mobile technologies, that have utility in different learning contexts (e.g. University, workplace, social spaces)

To support these requirements the design of an environment pictured in Figure 5 would ideally start from the perspective of an empowered mobile learner who possesses a personal and portable piece of technology. Returning to the organisational and pedagogic objectives of the DLP introduced earlier in the article, this outcome would be philosophically consistent with the programmes social goals, and would support a constructivist approach to learning that promotes sharing, is learner centred, supports lifelong learning and is situated in the learners own context.

CONCLUSIONS

Implications of m-learning for distance learning

In this article, we have provided a historical perspective on an evolution of distance learning that has embraced e-learning applications, and is now seeing the potential contributions of m-learning. We are at an exciting stage, which is likely to lead to a significant turning point in the way distance education is designed and delivered. In the context of the DLP, the implications are as follows:

- Explore co-authoring of OERs with both collaborating institutions and increasingly with students
- Support the development of repositories of learning resources, that promote ease of file sharing among students and between reuse by different institutions
- Link informal applications, social software and learning environments, so that from the learners perspective they all form part of their personal learning space, and they get the right balance between structured and flexible environments
- Focus on multi-media and support for different learning styles
- Design of m-learning is contingent on context, student profile and subject matter, and these aspects need to be clearly understood

All these strategies should promote development of applications and resources that are as accessible as possible to the mobile user. However, this is not to suggest that use of mobile technologies can ever provide the full environment. The jigsaw will continue to have face to face, e-learning (web and PC based) applications and make use of printed media and other technologies.

To deliver a coherent version of this kind of reformulated model also requires rethinking assessment, quality assurance, authentication, plagiarism detection, administration and processes for authoring that efficiently produce learning resources for use on different media. E-learning has already created momentum for work on these areas, but a lot more would need to be done.

Existing programmes will need to evolve and re-orientate, but new programmes have the opportunity to invest in well designed mobile learning environments from the outset and treat the mobile learner and m-learning as an important first piece in a jigsaw. Fixed set up costs for distance learning are high, so it is important to plan early for the future. The new generation of learners coming out of schools, have different expectations and already make significant use of many of the component applications shown in Figure 5.

Distance learning is truly coming of age, and offering huge scope for innovative solutions. Most importantly, when m-learning approaches become embedded and fully accessible, distance learning also has increased potential to be used strategically to address the access constraints to higher education in developed and developing countries, and support organisational training and professional development in new ways. The potential for connecting distance learning and m-learning approaches to global agendas such as poverty reduction, sustainable development, HIV/AIDs and climate change cannot be ignored within international development. It is an important ICT4D strategy and consequently cannot be ignored by distance learning programme designers working to contribute to education in developing countries.

M-learning has the power to extend or reformulate distance education models. It is not a complete solution, but offers potential to address problems of access; supports learners who are mobile and want to study at their convenience; and provides the option of engaging with learning communities, and making use of different media according to individual study preferences.

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MAKING THE CONNECTIONS: THEORY AND PRACTICE OF MOBILE LEARNING IN SCHOOLS

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ABSTRACT

This paper reviews several major theories of learning, and considers what additional theories might explain 'mobile learning'. It then describes three small projects in Year 6 classes in English schools–where teachers and students used mobile devices over a period of several months–in order to make connections between theory and practice, and to seek new insights for theory from practice. The study found that behaviourist, constructivist and socio-cultural theories influenced teachers' work, often simultaneously, while there was scant evidence of a symbiotic relationship between people and technology. The paper concludes that even in these early days of mobile learning in the mainstream there is clearly a need to consider changes in the nature of time and space, exemplified particularly in the relationship between home (parents) and school. It suggests that practitioners and researchers should work together to develop theories that will be useful in understanding and guiding practice.

Keywords
Theory, mobile learning, teaching, primary school.

INTRODUCTION

Theories of learning
With increasing use of communication technologies, and claims of their potential for supporting learning and the construction of knowledge, theorists have been searching for explanations and paradigms for what they believe is a new phenomenon: 'mobile learning'. In particular, the potential for learning outside formal educational settings has been recognised and in some cases, a perceived failure of schooling has led authors such as Papert (1994) to call for a different kind of theory of learning, rather than the school's kind. We might be wise, however, to keep in mind Skinner (1950) who asked 'Are theories of learning necessary?'

A scan of the major theoretical positions of the past century reveals threads of behaviourist, constructivist and socio-cultural theories of learning, developed mainly from the work of psychologists, that continue to have influence in the present day. Behaviourism sees the learner as a passive recipient of information, able to be trained through classical conditioning (Pavlov, 1927). It focuses on the acquisition of skills through reinforcement and reward (eg. Skinner, 1950) and has been applied in both schooling and training contexts in recent years. The characteristics of the environments influenced by such theories can include learning by doing, use of taxonomies, explicit objectives and outcomes, personalisation and just-in-time learning, but emotion and uncertainty are not encouraged. On the other hand, constructivism flows from Dewey (1910), who viewed learning as the process by which people construct knowledge, with that product containing the meaning of objects and events. Therefore knowledge building is a constructive activity directed towards the creation of knowledge itself, while learning is a personal consequence, enhancing one's own abilities and dispositions. Similarly, Bruner (1986) placed emphasis on problem solving and the processes of coming to know, including mental models, metacognition and self-regulation rather than knowledge that could be transmitted.

Socio-cultural theories can be traced to Vygotsky (1962), who believed that the environment mediated individuals' activities. Higher mental processes in the individual have their origins in social processes and can be understood by studying how they are mediated by tools, artefacts and signs. Vygotsky emphasised whole activities rather than skills and sub-skills. But unlike Dewey, he believed that the development of spontaneous concepts, through the child's own mental efforts, and the nonspontaneous (or scientific) concepts, decisively influenced by adults, were part of the same process. Therefore as learning is a process involving activity and reflection, and both scientific and spontaneous concepts, there can be no limits to where it takes place. Vygotsky's Zone of Proximal Development (ZPD)–the distance between a learner's actual developmental level as determined by independent problem solving and the higher level of potential development under guidance or in collaboration with more capable peers–recognises the part teachers and other adults, as well as other students in the social context, have to play in scaffolding learning.

Both constructivists and socio-cultural theorists have aspects in common with the proponents of situated learning, who argue that meaning is a product of activity and the culture and context in which that activity

occurs (A. Brown & Palincsar, 1989; J.S. Brown, Collins, & Duguid, 1989; Lave & Wenger, 1994), and they take into account the immediate physical context as well as the social and historical context (J.S. Brown & Duguid, 1996). Students in a situated learning environment engage in authentic learning activities which have a clear purpose for the learner or society beyond simply demonstrating skills, allowing students to learn in real contexts where they are applicable. Wilson (1993) proposes that authentic activities must be located in the actual situation of their creation and use, not in the artificial environment of the school. In contrast, Honebein, Duffy, & Fishman (1992) suggest that an activity within formal education is authentic when the learner has ownership, in that it is not seen purely as the teacher's task. In using the term 'constructionism', Papert (1991) extended these ideas to incorporate manipulation of materials, believing that that learning is most effective when learners are able to construct a meaningful product. He noted research evidence indicating students are motivated by making, rather than merely using, software, such as developing their own computer games.

The multiplicity of social networks and personal identities is of interest to theorists. Siemens (2005) has presented ideas towards a social theory of learning–connectivism–that, he argues, addresses the connections between multiples nodes (people and information sources) enabled by technology. These ideas have yet to develop into a full-blown theory. Damarin (1996) suggests that in any case, a student is not a single knower, but a confederation of many knowers: moving from one situation to another and drawing on the knowledge appropriate to the new situation. In school then, a teacher's task is to support the growth of each situational knower as well as his or her confidence to move between situations such as home and school, and among social subgroups. In other situations, other sources of information and support might play a similar role.

The author's previous research in classrooms where teachers and learners used computer technology in their practice of building knowledge identified four roles of teachers: i) designing the learning environment, ii) managing people and resources, iii) mediating student learning and iv) improving practice (Hartnell-Young, 2003, 2006). That teachers themselves were also learners moving between situations was central to the teachers' understanding of their professional roles. A view of teaching as knowledge building is based on creating new knowledge *with* learners, often in a context of uncertainties. Students are now recognised as having expertise in areas that teachers do not, particularly due to the greater access to global information and publishing tools of recent years. Some suggest further that the structure of teachers' roles will change dramatically in future, as the tasks of teaching and learning become distributed among many teachers rather than done by each teacher (Beare, 2001; Cornu, 2001). In fact the reconceptualisation of 'teacher' is influenced by the relationship between learners (in the broadest sense) and technology, and mobility is a feature of this relationship.

Mobile Learning
The term 'mobile learning' is contested, and underpinned by many different theories of learning (Winters, 2007) and beliefs about people and technology. Several of the emerging theories in the mobile learning research community address the relationship between humans and technology. Dholakia and Zwick (2003) argue that a postmodern theory of technology is required, challenging the dichotomy between humans and technology. Modernist theories have led to both the instrumental view that technological systems are value-neutral, offering tools ready to serve the purposes of their users, and the substantive view, which argues that technology is value-laden, capable of over-writing cultural systems through surveillance and control. They argue that mobile technology opens up the possibility of a dialogic and symbiotic relationship, as technology becomes a part of us and merges with our sense of autonomy. This allows a more humanised conception of technology, obvious today in wearable products. Further, they suggest, mobile technologies affect the experience of 'self' in time and space by altering the nature of both.

Sharples, Taylor and Vavoula (2007) argue that a theory of 'mobile learning' must differ from current theories of classroom, workplace or lifelong learning, because traditional classroom learning is based on a fixed location with common resources and an agreed curriculum, while mobility of learning allows transfer of knowledge and skills across contexts such as home and school, and across life transitions. They build on Activity Theory (Leont'ev, 1981; Engestrom, 1987) to focus on the communicative interaction between learners and technology–in that both are able to converse with each other–where 'ownership' of the resulting knowledge is shared. However they acknowledge that their paper gives scant attention to the role of teachers in learning.

Using Actor Network Theory (Latour, 2005), which also considers humans and technology as actors with agency, Tatnall and Davey (2003) suggest that 'mobile learning' should be viewed as an innovation, and they offer a way to understand some of the difficulties inherent in its adoption. They suggest that acceptance of an innovation is affected more by the complexity of the interactions between the people within an organisation than by the characteristics of the innovation itself, and therefore propose an innovation-translation model (Latour, 1996). Translation is here the means by which one entity gives a role to others. All factors which influence adoption are actors, and the combinations of these factors are networks. Rather than seeing society and technology as separate, this leads to a socio-technical approach, whereby actors of all types can assist or hinder the adoption of an innovation.

This paper does not propose one theory to explain what is going on in schools with regard to mobile learning, but seeks new insights for theory from the practice.

RESEARCH METHOD

Three small projects in English primary schools in the early stages of 'mobile learning' were identified by the researcher. In the cases reported here, 'mobile learning' means that a teacher and all students in a class use mobile devices, linked to a local area network or a telecommunications provider, for curriculum activities. All three classes consisted of Year 6 in suburban schools in different cities, although B and C were in lower socio-economic suburbs than A. In each case, only one teacher in the school was involved, over a period of months. The data come from school policy and curriculum documents, semi-structured interviews with three class teachers, two consultants and two parents, and observations of sample classes on several occasions, which were recorded and photographed. After preliminary coding, the data were considered in light of the theories outlined above, in order to seek new insights.

FINDINGS

In this section, each of the three schools is considered in turn.

School A

The school brochure stated some of the school's aims:

> We aim for high standards in terms of behaviour, academic work and physical and creative achievement. Art, music and sport form important parts of the curriculum. Whenever possible we offer first hand experience, believing that it is through this personal experience that children learn to use and apply the skills they are taught.

Here one of the teachers initiated and designed work with mobile phones with his class, using his expertise and interests, because, 'after using smartphones, including a word processing programme, digital photography, calendar and a diary, with a Bluetooth keyboard to allow input, it began to occur to me that it might be possible to use such devices in the classroom'. He believed it was impractical to keep mobile phone technology out of schools, as the students carry their own phones anyway, and stated 'Far better to use the technology for educational good…The earlier we begin to understand how to utilise this technology the better.' One of the considerations for this teacher was giving students access to computers: 'It has always been accepted that the ideal would be one computer per person, but education cannot fund this. Now we are in the position that our clients are funding the computing power: we just need to use it.'

He worked independently, and succeeded in gaining funding for a small set of camera phones which were kept locked in a box in the classroom and used for particular activities. Other networked technologies included an interactive whiteboard and the teacher's laptop (as shown in Figure 1). Thus the teacher designed the learning environment and maintained boundaries. Notwithstanding this, he said he learnt from his students 'to have an open mind'.

Figure 1: Mobile phone storage and other technologies in the classroom, School A

In line with the school's aim to give first hand experience, and to take advantage of the location-awareness potential of the mobile devices, the teacher designed a hill trail activity for his class and another parallel class. The 'away team' was equipped with a mobile phone with a GPS receiver. When the students reached one of the numbered points they took a picture of the terrain and sent it to a website based in m-explore (www. http://order.m-explore.com/start.php). The 'home team' at school monitored the arrival of new images on the website and checked whether the 'away team' was on track by comparing the map on screen, and the location of the picture, with the Ordnance Survey map showing the route of the trail and the different marker points. Then, using the text back facility of m-explore, they sent a text message from the website to the mobile phone to confirm the away team was in the right place. Success was measured by none of the groups on the hill trail becoming completely lost. The teacher reported that the 'away team' enjoyed using the phones while the group at school had the challenge of comparing the two maps. The equipment and the website worked well, although, he said, more detail on the map would have increased the ability of the children at school to give detailed reaction to the photos.

In a further development of this type of work, students took the set of phones on a class weekend trip. They uploaded numerous photos and text messages to m-explore to record their experiences (left hand side of image in Figure 2) and so that parents could see where they were (on the map, right hand side). Parents accessed the site frequently over the weekend to see what their children were doing.
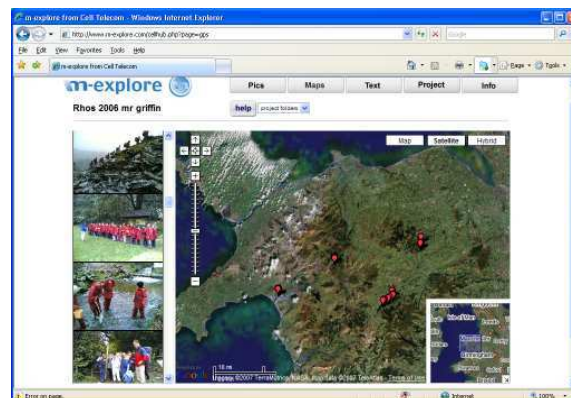
Figure 2: Screen shot from m-explore, School A

With all the activities using the mobile phones, students did not see a relationship with their curriculum, but viewed them as an additional activity. They did not have ownership, either of the devices or the activity. This was exemplified by one boy who said 'I like it because you get to use computers instead of proper work'.

From the teacher's point of view, 'portability' and 'immediateness' were the most important benefits of using the devices. The biggest problem was 'the hardware and the software impeding learning'. While the mobile phones were good for word processing in class and for taking images and video, there were

problems connecting with the whiteboard via Bluetooth for whole-class viewing. However he remained motivated to continue his explorations with mobile learning.

School B

In its prospectus, School B claimed:

> Children learn best when their motivation is high, and therefore developing self-confidence, positive self-esteem and skills of communication are of great importance. Children should be encouraged to develop skills of self-evaluation and to view their achievements in a positive way.

Here, a Local Authority e-learning consultant invited one Year 6 teacher to trial a set of Personal Digital Assistants (PDAs) purchased by the Local Authority. Students had 24/7 use of the device from September until April, and the consultant provided training for the teacher and students at the same time through regular class visits. The teacher was open-minded, keen to learn and very skilled at teaching within the curriculum, stating early in the year 'we are working fast and hard towards SATS' (the national tests). While achievement in literacy and numeracy had been lower than the UK average in this school, the inspection authority (Ofsted) noted that achievements in information and communication technology (ICT) were above the expected levels. The teacher mediated learning in a range of ways, using behaviourist approaches (such as drills) to achieve particular learning goals in spelling and grammar, as well as a constructivist approach whereby groups of students developed solutions to problems in all curriculum areas. She knew very little about PDAs and their uses at the outset, but had a laptop, video camera and interactive whiteboard in the classroom. Figure 3 shows the typical classroom layout.

Mobility of students was limited during class time. The teacher said 'PDAs have supported the kinaesthetic approach to children's learning: physical involvement, movement around the space in the classroom and open discussion and fun' which she thought was particularly good for the boys. Students were observed sitting and lying on the floor, and using the nearby corridor for video recording. On the other hand the teacher believed 'the main benefit in class is that the children have been able to access the Internet from their tables in the classroom since the introduction of the wireless network point'. Figure 4 shows a typical scene when students were working with their PDAs, pens and paper, based around their desks.

Figure 3: Classroom layout, School B   **Figure 4: Students at work, School B**

The greater mobility offered by the capacity to cross classroom boundaries, particularly the home-school boundary, was exploited through using the PDAs for homework tasks, transferring contents to the school network for viewing through the interactive whiteboard, and allowing students to create their own content, especially through video. One parent expressed her approval: 'If they do a lot of work on PDA you're more in control of knowing what they've been doing in school. If all the work was on the PDA you'd know more, wouldn't you?'

The conversation with parents revealed an instrumental view of the technology. When asked 'What are the PDAs capable of?', this dialogue ensued:

'Everything the PC is'. (Parent A)

'Just a smaller version isn't it really? It's just like a computer but using it with a stick.' (Parent B)

'The boys have had the Nintendo DS, so it didn't take long for them to pick it up.' (Parent A)

'"Can I have one of these for Christmas?" he said. But he's got the play station, he's got a PSP, and the computer, and at the end of the day you can't do them all in one go'. (Parent B)

The teacher was very ready to see herself as a learner with regard to the technology: 'Children are daily teaching me how to use the PDA. They often show me things they have discovered. I also have to ask the children who are IT literate for support in class. It's developing quickly the ethos that we have a

shared learning environment–never too old to learn–and supports the raising of individual children's self esteem.' She also realised that she was expert in some aspects: 'Children have been very supportive of each other, willing to share their ideas but teaching support is needed for their speaking, listening and questioning skills'. This teacher's practice exemplified much of socio-cultural theory, including the use of Vygotsky's Zone of Proximal Development to move learners on.

As if to bear out the words of the prospectus, the teacher reported that motivation among the students was very high, with an unexpected 100% attendance in the class over the period of using the PDAs. (Ofsted had preciously commented that 'one of the most important things the school should do in order to raise standards in all subjects is to continue to develop ways of improving levels of attendance'.)

Students with special needs were willing to begin work without a teacher close by, and this was attributed to both the novelty factor of using the devices and the spelling support offered by the PDA software. The teacher noted that many students '…love to play on PDAs. They see it as play.' Other students practised the skills of communication in several situated and authentic ways. They frequently used the video-recording feature of the PDA, even moving beyond the National Curriculum to conduct student-initiated activities such as interviewing visitors and capturing evidence of their activities (Hartnell-Young & Simner, 2007).

School C

Located in an ethnically-diverse community, the school's mission statement included the following outward-looking aim:

> …to ensure our pupils leave with a strong sense of personal, moral and cultural values about themselves, the world and the society in which they live, are able to make confident contributions and become happy and productive citizens of the future.

In this case, the largest project of the three, a second Local Authority invited teachers from three Year 6 classes, including one in School C, to explore uses of PDAs prior to using them in the classroom. None of the teachers had used PDAs previously. Some initial training and follow-up support was provided, with a project officer visiting both schools weekly. Later, students had 24/7 use of the device. The project officer ran clinics for them once or twice a week, and attended meetings to plan classroom activities with the teachers. The class used the Remote Display Control for Pocket PC facility to connect the PDAs to the interactive whiteboard. They stored their work in folders on the network by connecting them to the class PCs, and many students used the Bluetooth facility to transfer files.

The teacher found that motivation was high: 'They're good for motivating children across a range of tasks, and for gaining pupils' interest and attention. The children enjoy writing up their knowledge of certain topic areas, then presenting their findings to the class using the remote connection to the interactive whiteboard, which displays their work as a presentation for the class to see.'

The PDAs also facilitated home-school links, according to the teacher: 'The children have loved taking them home. Many of them have taught their families how to use them, and it's always interesting to see what they've been doing over the weekend.' This teacher valued the out-of-school lives led by her students, and could then build on their experiences using a constructivist approach. 'Many of them make videos and take photos, and quite a few have downloaded music to play to others back in class.' The school received positive feedback from parents about 'how knowledgeable their children are on the PDAs'. Behaviourist approaches were also used to achieve this, such as students keeping personal spreadsheets of their spelling scores in tests, and writing words down to learn with links to definitions. 'We have used them for reading, learning spellings, Science revision, maths games (learning facts/tables etc), researching topic work on the internet, looking up images of things related to our lessons. They have also used them for homework: reading ebooks or revising presentations for Science topics.'

The consultant working with the school also used a constructivist approach, stating 'We left it to the children' and 'We are looking at what children can produce', and using words such as 'exciting' and 'enriching'. In line with the outward-looking mission statement, she encouraged students to produce podcasts, by using the PDAs as recorders and taking the recordings home as well as uploading them to a website. These podcasts were recorded in several languages, reflecting the diversity within the school community. Students went outside the school on organised excursions to historical sites, including a local hotel, and created a historical reenactment at the local manor house. However the consultant acknowledged that these activities make assessment 'tricky', and at present student-generated digital products are simply assessed 'as any other piece of work'. In future, she suggested, home-school links

could be strengthened by 'video machines that parents could log on and tune in to the classroom' and 'it would be even more brilliant if the child could consult their family like "phone a friend"'.

Although the project was not initiated by the class teacher, putting the PDA into her hands was an intervention which appeared to have positive results for her. She reflected: 'I've enjoyed having the opportunity to try out the PDAs with my class, and the PDAs have improved my personal understanding of this type of technology.' There were certain tasks, mainly involving extended pieces of writing, when she preferred students use a full-size PC 'as it is much quicker for them to use the keyboard to type than the stylus to write words'. However she continued 'It's work trying to solve technical difficulties yourself. Once all the technical difficulties are sorted, their use will increase tenfold!!!' (sic).

DISCUSSION AND CONCLUSIONS
The teachers in these three cases displayed all four roles (Hartnell-Young, 2003) to varying degrees. In terms of designing the classroom learning environments and the curriculum framework in England, teachers displayed little agency. In School A the teacher initiated the mobile learning, while in Schools B and C others did so. However the latter teachers were more prepared to encourage the students to explore widely by designing open-ended activities and listening to suggestions from students. The teachers raised many issues to do with managing the technology, such as ensuring the security of expensive devices, and that batteries were charged, connections could be made, and PDA styluses accounted for. However these did not overwhelm them, and they often involved students in the management of the class in this way. Teachers displayed different theoretical underpinnings (from behaviourist to constructivist and socio-cultural) in mediating learning, often within the same activity, indicating that they are pragmatic in drawing from a wide repertoire as they saw fit. Not surprisingly, behaviourism was most evident in the responses to the National Curriculum's outcomes focus and the national testing, mentioned particularly by the teachers in Schools B and C, whose schools were concerned about improving students' scores. However these also displayed a more constructivist approach than School A. Although based on limited data, these findings appear to indicate that 'mobile learning' might draw on several of the major theories to varying extents.

All teachers showed that they were keen to learn and to improve their practice, both by learning from their students and from peers. In this case, none attended formal courses, but gained their knowledge from experience, trying out something new and reflecting on it (a socio-cultural model). The classrooms operated as learning communities, with the teachers sometimes expert, sometimes not. Apart from School C, where the teacher and students interacted with others using PDAs in local schools, the devices facilitated little boundary-crossing or connection between school communities. However two-way links to the Internet and to other people were initiated, sometimes by the students themselves.

In the situations reported here, humans and technology remained as a dichotomy. In none of the cases did the teacher, nor the students, appear to exist in a symbiotic relationship with the technology. Neither owned the devices in question, although they owned and used other similar devices in some cases. In School A the devices were locked away when not in use, underlining the disjunction between learner and technology. Technical difficulties, particularly reported by Schools A and C, make it difficult for learners to feel there was a symbiotic relationship with the technology, while the two parents interviewed did not report any sense of symbiosis, in spite of positive experiences.

In Schools B and C, where students had constant use of the mobile devices, there was evidence of a growing sense of autonomy, as students created their own uses to meet personal purposes. These could be called authentic activities (Honebein et al, 1992). In contrast, in School A, activities were devised by and under the control of the teacher, although they took advantage of the communication possibilities of the mobile devices.

Sharples et al (2007) indicate that the mobility of the learners is an important feature of 'mobile learning'. This was evident in small ways during the school day, as students moved around their classrooms, into corridors, and occasionally on excursions. However, as Sharples et al might predict, crossing of the home-school boundary occurred in all three cases, and was the greatest mobility observed. In Schools B and C, parents were said to be more involved in their children's homework, communicating on the devices with the schools, using the devices at home themselves and learning from their children. The

role of parents, and indeed, of industry experts and community members, should be considered as part of a theory of mobile learning.

Teachers generally saw the important connections as being with family. Even in School A, where the devices were not available round the clock, parents engaged in a new activity, virtually attending their children's weekend away. If one of the purposes of a weekend away is for students to practice independence, this raises concerns and could lead to greater control and surveillance (of students and teachers). Similarly, the idea of a video link where parents can tune in to the class to see their children (mentioned by the consultant to School C) has both positive and negative implications, but it perhaps foreshadows what Dholakia and Zwick (2003) refer to as the altering of time and space. This area is rich for further work on both theory and practice, so that school communities will be able to make appropriate and sensible decisions about such issues.

In each case, introducing mobile devices into the school for curriculum use was an innovation, and Actor-Network Theory (Latour, 2005) could be useful for understanding the experience. While it is too early to make judgements about success in these cases, some of the actors involved are becoming clearer, including school policy and mission, curriculum and assessment, devices, infrastructure, students, teachers and parents. Even the construct of pilot projects with short lives, and the likelihood of giving up the devices, is likely to be an actor in this regard. In each case reported here, the National Curriculum and preparations for national testing of Year 6 students had a strong influence on activities. Tatnall and Davey (2003) suggest that it might be possible to avoid mistakes in practice by taking the knowledge of such actors and their interactions into account.

The relationship between theory and practice, researcher and practitioners is more intertwined than the title of this paper might suggest. Future work in the field of 'mobile learning' will benefit from close ties, including teachers researching their own roles and practice in learning communities. Where practitioners and researchers work together, they can develop theories that are useful in understanding and guiding practice. While primary schools offer relatively self-contained sites for studying the phenomenon of mobile learning, as in this paper, secondary schools are thought to be more difficult, due to their populations of older and more mobile students, and complex organisational structures. Recently, however, several projects have started with secondary school communities in the UK, capturing and reflecting on their experience in order to inform theory and practice.

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21ST CENTURY ASSESSMENT FOR 21ST CENTURY LEARNERS

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ABSTRACT

"All Jamie needs to do is watch this video on my PDA of him batting, and he'll see straight away how to improve. I'll give it to him now."

When 21st Century learners are using mobile technology in this way is it not time our existing assessment techniques caught up?

This paper identifies the many ways in which mobile devices are being used to formally and informally assess learners at Stow Heath Junior School in Wolverhampton, England. We attempt to outline how traditional methods of formative and summative assessment of both the ICT capability of learners and their development across the curriculum are being undertaken using mobile devices. And ask questions about the value of traditional assessment techniques in an educational environment where learners are able to assess both themselves and their peers with such ease and confidence.

Author Keywords

Assessment, formative, summative, peer assessment, "Synchroneyes", "Eduinnova".

INTRODUCTION

Since 2002 Wolverhampton Local Authority has been one of the leaders in the use of PDA's within UK schools and Stow Heath Junior School has been involved in the Wolverhampton "Learning2Go" mobile learning project since its very inception. Wolverhampton is in the industrial heartland of England, charcterised by areas of significant deprivation, unemployment and "digital divide" and for Stow Heath the mobile devices were seen as an extension of the good practice already evident within school.

The project started with just 14 devices placed in a Year 6 classroom, as part of a BECTA pilot project, the project within school now involves some 200 learners with their own personal mobile device which is available for them to use both in school and at home. As a result of this 24/7 access to the technology the true potential has been uncovered by the learners themselves in their willingness to experiment, to learn from others and to pass on their new-found expertise to their teachers and peers. And it is "ownership" of the project by the learners that has become the defining aspect of "Learning2Go."

"Learners voice" has been key to the success of the project so far. The Learning2Go project has as its ethos the belief that learners should have the choice and self-confidence to learn when, how and where they want. The project promotes a personalised learning experience, in which the learners are responsible for managing their own mobile handheld computer and helping to shape both their own learning, and through peer assessment, the learning of others.

The following beliefs characterise the project ethos:

- The learners has the device 24/7
- The teacher is key - if the teacher has not planned for using the device or is not enthusiastic about the possibilities, then it will not be used.
- Learners can and will become more expert than adults.
- Complete wireless coverage is provided in school
- Content and applications are of equal importance.
- Learning is assumed to take place at different rates and at different times.
- Collaboration and peer support are encouraged.
- Learners share the technology with their families.
- Learning through play – 'plearning' as one child dubbed it – is valued.

Some of the educational impacts that have struck experienced observers of the kind of innovation introduced by Learning2Go include:

- Changes in the quality and breadth of learning and access to information, its ownership and learners' motivation.
- Changes in the nature of the relationship between learners and teacher.
- Changes in the relationship between parents and teacher, home and school.
- Innovative opportunities for integrating assessment into teaching and learning that can impact profoundly on pedagogy. (Russell and Whyley, 2006).

It is this final bullet point that this paper is mainly concerned with by offering a descriptive and explanatory overview of the work already undertaken and recommendations for moving both digital assessment and the project forward.

Stow Heath has a tradition for developing innovative and creative methods of self-assessment but the development of mobile learning through the Learning2Go project has resulted in unexpected assessment techniques instigated by the pupils themselves.

INFORMAL PEER ASSESSMENT

It is clear that within everyday classroom experiences learners have many opportunities to assess both themselves and their peers. This has been particularly evident since the development of the mobile device as opportunities immediately present themselves to 21st Century learners who are both creative and discriminatory. Teachers have found new methods of delivering both the National Literacy and Numeracy Strategies, for example a year 6 literacy group at Stow Heath were reading Macbeth and were asked to read and audio record passages from the script. Learners worked in groups on the activity and discovered that by instantly connecting their devices to classroom speakers and interactive whiteboards the same passage could be read in several different ways and with different emphases. Clearly this has always been possible with the use of tape recorders however with the mobile device every child has their own copy to keep and can "beam" their audio files to their peers for analysis.

Recently at Stow Heath we have been experimenting with the use of video analysis during physical education activities to improve the performance of learners. Learners are split into groups with each group having a mobile device with built in video and stills cameras and skills are taught. During the session all learners have the opportunity to be videoed and to have their performance analysed. This is proving to be an extremely powerful form of pupil peer assessment as learners can comment constructively on each others skills and explain how something could be improved. During this analysis the teacher is then able to collect the videos and plan future lessons to address the specific areas for development. This is a significant stride within PE as teachers have traditionally focussed on a particular child or group during parts of the lesson and missed some of the work of others. By collecting the videos of all learners, teachers have a clear picture of the work of all.

Figure 1. Year 6 learners performing sequences during PE whilst their peers video and photograph their work for analysis.

SOFTWARE AND APPLICATIONS FOR DIGITAL ASSESSMENT

Wolverhampton Local Authority has engaged with a number of partners through the Learning2Go project that have worked with us at Stow Heath to develop innovative and engaging software to enhance assessment for learning opportunities. This software is beginning to challenge our more traditional methods of assessment as being more relevant and more appropriate to the needs of our learners.

"Synchroneyes"

"Synchroneyes" was developed as a classroom management tool for use within ICT suites. However, following discussions with pupils at Stow Heath a PDA version was developed which enables teachers to view all PDA's through the interactive whiteboard when the pupils are connected via wireless. The software allows the teacher to constantly monitor pupils' work so and to share the work with the rest of the group. Each device is displayed as a thumbnail which can then be broadcast to all users, observed and annotated by individuals or the group as a whole. In addition files can be transferred to and from the

teacher so a particular document can be wirelessly "copied" to all or some devices, worked upon and then "copied" back to the teacher.

Within the software there is also the option to generate quizzes and voting facility. Both of these applications are becoming increasingly common tools within classrooms to assess the progress and understanding of learners. Including the facilities within the software ensures that both teachers and learners are familiar with the functions and layout of the software.

A powerful example of the software capabilities is illustrated below.
During a maths lesson the learners were exploring a problem involving area. The 11 year olds worked together in groups to formulate a method which they then shared with the whole class. Each group was able to illustrate their thinking visually by broadcasting their work to each other's mobile devices for discussion. The group then decided upon an acceptable solution to the problem based upon their own thinking and collaborating with others whilst testing methods out.
The learners were then able to save their work to their mobile devices and were able to apply the successful strategies to similar problems in future maths lessons by opening saved files on the devices and referring back to previous work.
Following the analysis of the end of year statutory maths tests, it was found that many learners had applied the strategies explored during lessons to answer a similar question correctly. This suggests that learners who have the opportunity to approach problems in a collaborative, hands-on manner retain information more effectively.
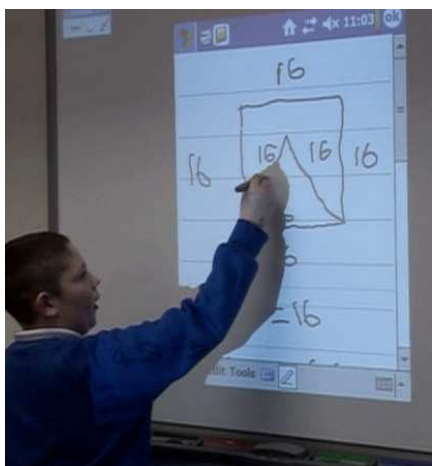
Figure 2. "Synchroneyes" used to project and broadcast work during a maths lesson.

"Eduinnova"
Having a mobile device is personal, but it is not a solitary learning experience. (Wolverhampton Learning2Go website)
During the last year we have worked with the Catholic University of Santiago, Chile to develop the use of Eduinnova in our classes. The aim of the software is to engage the learners in asking sophisticated questions about their own learning. The structure of the software ensures that all learners are taking part and responsible for contributing to discussions and making decisions as a group. At its inception the project sought to explore the innovative use of handheld computers to foster collaborative learning, focusing in on dynamic speaking and listening and opportunities for developing interpersonal and social skills. The Eduinnova system also offers teachers an unprecedented level of support for planning and classroom management.

Activities assign learners randomly to groups of three who then work together to solve a series of challenges on their individual PDA. The teacher poses a question and learners work individually in the first instance to provide an answer. Once each member of the group has submitted their response the group will see the three different answers. The learners challenge is to agree on the correct answer and submit this to the teacher. Only when each group has submitted their agreed answer will the software move on to the next task. Thus ensuring that through discussion, each learner has consolidated their final answer.

We have been particularly impressed by the degree of cooperation that results, even between learners who normally find it very challenging to work together. The nature of the Eduinnova activity design means that each group member must play a part. Learners who would not normally speak to each other quickly settle to work.
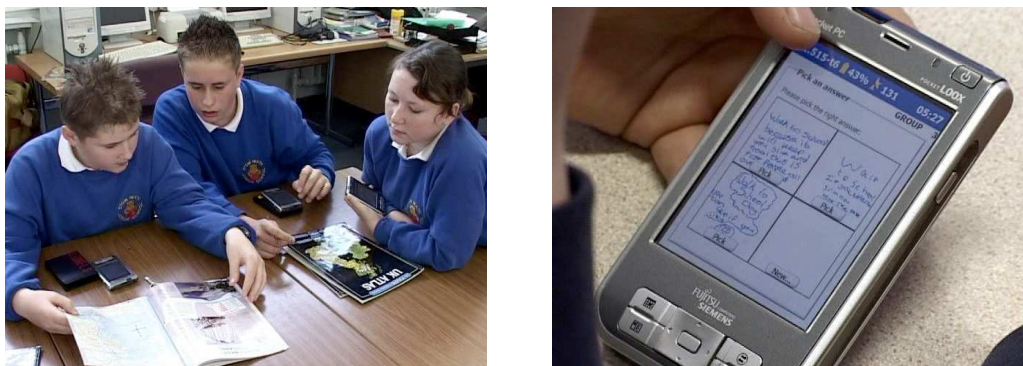
Figure 2. Learners working in threes to research an Eduinnova question and seeing the group responses.

The degree of enthusiasm and engagement witnessed at Stow Heath was no surprise to the three visiting researchers from Chile. They have been working to perfect this system in schools across Latin America. An exciting extension to the project at school was the ability to combine work on the PDAs with work on the interactive whiteboard which brought true teaching power to the plenary sessions. Being able to share a view of any student's PDA instantly with the whole class added a new dimension of assessment to the Eduinnova model.

Management software not only allows teachers to create and edit content easily and quickly but offers a real time view of who is doing what in the lesson. An instantly interpretable coloured grid guides the teacher to the groups who need some help. A click of the stylus takes the whole class to a problem everyone needs guidance on. Everyone's results are stored on the teacher's PDA to help with planning the next lesson.

E-Portfolio's

Continuous and developmental assessment is being approached through the use of the school e-portfolio. Each learner has access to their own e-portfolio which they update as appropriate throughout their time at school. Each piece of work is subjected to self assessment by the pupil and can be viewed by both teachers in school and parents at home as the e-portfolio exists within their web mail. This enables significant connectivity between home and school and parents are playing a much greater role in their child's learning.

The concept of the e-portfolio at Stow Heath began when a group of staff visited schools in Melbourne in 2001 and is now a significant element within Wolverhampton's e-strategy. (Wolverhampton LA, 2006). Then the e-portfolio existed as a word processed file on a standalone PC in the classroom. Some six years later the concept has at its core the following principles:

- A place to collect and share work which the learners values

- All work is digital and accessible from the internet

- A method of collecting and assessing key learning moments.

- Learners select their work with support from school

- Parents can see digital work for the first time

Clearly such a portfolio of work becomes a highly valuable reference point not only for the learners and their parents, but also for the staff in school and subject co-ordinators monitoring and moderating work in their subject. Learners are beginning to adopt highly sophisticated measures to decide whether a piece of work should be included in their e-portfolio or not and statements such as, "this is much better than the last time I tried this" are becoming common place.

CONCLUSIONS
In order to assess the "effectiveness" of our school, traditional assessments in the form of national tests are undertaken each year. Clearly as Russell and Whyley, (2006) argue it is unlikely that policy-makers will easily move from this method of auditing the education system in favour of more learner-centred and pupil learning outcomes. Perhaps what is more likely is that a new measure of effectiveness in the form of the quality of the outcomes achieved by learners and their ability to explain their progress is measured, rather than it be demonstrated in pencil and paper form.

Wireless networks are enabling the immediate display of pupil work through the effective use of the interactive whiteboard. This is ensuring that all work is valued and collected digitally to inform future planning and indeed to adapt planning during lessons. Therefore assessment for learning is immediate and effective and as our teachers at Stow Heath become increasingly adept and responsive to the learners voice as they tell them that "Jamie's batting will improve if he watches his video" then our teachers will make learning even more effective and engaging. Only through continued developments, pilot projects, appreciation of the needs of digital pioneers and the embedding of current good practice will changes to our assessment techniques really emerge that reflect the m-learning capabilities of our learners.

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A STUDY ON UBIQUITOUS COMPUTER SUPPORTED COLLABORATIVE LEARNING WITH HYBRID MOBILE DISCUSSION FORUM

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ABSTRACT

With recent advances in information technology, mobile devices such as PDA phone or PDA have made a great progress. The mobile devices become more convenient and their usages increase, therefore more and more people will like to use mobile devices to manage daily information and tasks. Learners most utilize PIM (personal information management) on mobile devices to record information and help their daily life and learning. However, the usages of PIM target at personal use but not collaborative use. This research proposed a ubiquitous computer supported collaborative learning (UCSCL) mechanism and designed its corresponding system, integrated multimedia mobile forum named "StudentPartner" which employed both PDA and Web-based technologies. After that, one half-year experiment was conducted and the results found that the usages of both PDA and Web-based StudentPartner system would influenced each other and some interesting phenomena were worth further investigation in the future.

Author Keywords
Ubiquitous Learning, Mobile Learning, MCSCL

INTRODUCTION
With recent advances in mobile devices, such as PDA phone or PDA, mobile devices have made a great progress, and become increasingly popular. Users can not only take pictures, search information, exchange files and communicate with others with the wireless networks of mobile device, but also manage daily information and record tasks. Furthermore, mobile devices, in particular PDAs, were expected to facilitate, efficient learning. Therefore, the usage of mobile devices increased and offered frequent, integral access of applications that support learning anywhere, anytime (Debora 2003 IEEE computer). Franz and Holger (2002) indicated mobile devices were provided service of learners' need for acquiring secondary information by reducing time and effort normally. By providing access learning resources anytime and anywhere, palmtop computers were enabled students to make more effective use of time while away from the home or office environment (kukulska, 2003).

Refers to the education, users utilize personal information management (PIM) on PDA phone to manage learning materials. Although PIM helps learners to manage time tables, calendars, revise the meeting schedules, record tasks, and browser learning materials, the usages of PIM are targeted at personal use not collaborative use.Consequently, the quality and content of information is limited. To increase the quality and quantity of learning-based information, PDA system must provide tools for collaborative information management. This research proposed a ubiquitous computer supported collaborative learning (UCSCL) mechanism which was combined PDA phone and Web-based, and designed an integrated multimedia mobile forum named "StudentPartner". This research expects to allow learners access learning information anytime and anywhere to facilitate collaborative information management by using PC and PDA phone.

MOTIVATION
1.   The extension of time and location：Students' learning may not only occur in school. The mobile devices extended time and location of learning. Learners can use that not only in the campus which supported wireless connection but in home, trains and other outdoor environment. The proposed presented in this research, StudentPartner system, supports offline information browsed and inputted. Therefore, this research not only extended the learning location, but also enhanced the use of mobile devices.

2.   Lack of group learning system：Students most use the PIM tools on PDA phone to manage personal learning information, for example：notebook, calendar, timetable and others. Although this PIM tools can provide users a good information management tool, but these PIM tools are targeted at personal use not collaborative use. However, in the field of students' learning, collaborative learning is also important. Therefore, this research purposed a mobile forum to provide collaborative use.

3.   Lack of offline environment for access information：Wireless connection is very important when using PDA phone to access learning content and search information. Although the wireless network set up universally, the coverage of wireless network is not 100%. Therefore, users may have no wireless

connection to access information when using PDA phone. This research purposed an offline environment to access learning content. When there is no wireless network, users can read learning content and input multimedia data to forum in offline environment. After that, users upload and synchronize database to server, and synchronize the latest database to local database stored in the PDA once the PDA is connected to the network. These functions should increase convenience of accessing information and engage learners.

4.　　　Enhance the richness and immediacy of information：Mobile devices extended learning time and location. Users could not only use mobile devices to study learning content, but also input instant multimedia data (text, video, or audio) at offline environment in the traffic or outdoor journey. With this way, mobile devices can be a friendly input media. No matter where you are, users can immediately use PDA phones to capture image, audio, or video, and then post on PDA StudentPartner to share with group members.

RELATED RESEARCH WORK

Mobile devices
Numerous researches focus on using handheld for general purposes, about helping people to manage their daily life, working and studying things. Sharples (2003) purposed an organizer system which used PDA to manage and support study, and found some interesting results. These results contributed to the role of PDA on learning and helped us further explore PDA in the field of learning study. Those included the role of e-mail and instant message (MSN messenger).

Learners were attempted to communicate with teachers and peers in many ways. Learners sent the important and formal information by email and informal and urgent information was sent by instant messenger. Learners wrote email in PDA in offline environment and they sent the email until connect the network.

The another finding of Sharples (2003), was the users of PDA replaced their notebooks by using calendars, learning tables and notes on PDA, and managed their schedules, dates, and learning tasks everyday. In addition, PDA notified the learners automatically and this approach was more efficient for daily learning and daily life.

SMS and online forum
In learning environment, how to promote learning and encourage interactivity and facilitate student motivation is a important factor. Markett, Sanchez, Weber, Tangney (2006) proposed a mechanism of using short message service (SMS) in class to promote and enhance interactivity due to ubiquity of mobile phones among students. This research designed two tools, which one is in class, and the other one is after class. Students sent anonymous SMS to teacher via their personal mobile phones while they had some questions in the class content. Thus, lectures could collect these questions, and address these issues in the right time without interrupting the flow of events in class. And after-class tool was a database-driven website, providing students to extend the discussions in the class. This research purposed a number of scenarios, and provided an active learning environment to raise class participation. Although the results indicated students distracted by the SMS, most students would like to use SMS in class in the future.

Fu-Hsiang Wei, Gwo-Dong Chen(2006) had another research about using SMS to promote interactivity. Students read materials, annotated and discussed with each other in virtual classroom via pc or mobile phones. Moreover, learners could enter queries and ask a mentor to answer the questions. Learning system would inform peers (mentors) the question through instant messages, e-mail and SMS. When learners encountered problems by using GPRS or wireless network of mobile phones, they could record or photograph, and then sent the querying page to teaching assistant (administrator) via MMS or e-mail. After that, teaching assistant received the content, and then published the question on the online forum. This research purposed an active learning environment, encouraged students queries when having questions anytime and anywhere, and this approach was increased discussions and interactivity. The experimental results showed students can accept the mechanism, and the frequencies of querying and replying increased more than the general online forum (no mobile phones and no mentor mechanism).

Collaborative information management

Users could input information or the suggestion in collaborative way. Collaborative information input enriched information of system and let users have sense of ownership to this system (belonging). As the belonging increased, the users would consider the information was important and was contributed to them and then they would use the system more frequency. In this situation, there were more and more users to use the system to contribute the information input and the information would become richer and richer. For example: BBS or News. Moreover, for information consistency and correctness, there was a system administrator to manage the inputted information. Administrator, like a BBS board master, deleted the uncorrected and repeated information and they were able to input some important information (for instance: public announcements).

Mobile CSCL

Collaborative learning is among groups involved in an activity, and learners collaborate, share, and interact with each other to achieve the objective of education. Collaborative learning is widely used in elementary classrooms. However, when working traditional education without technology support, some problems could be detected. These issues were included coordination, communication, and negotiation, etc. Although personal computer could solve these social interactions, however, these CSCL was still occurred some problems. These issues included interrupted interaction, because students might focus on their owner personal computer and this situation was lack of interaction and mobility. Therefore, all of them could be address with mobile devices (Mobile Computer Supported Collaborative Learning , MCSCL) to reach the objective of collaborative learning (Zurita. Nussbaum, 2004).

Zurita, Nussbaum (2004) conducted two experiments, and the collaborative activities were analyzed with and without technological support through classroom observing, interview, etc. Each experiment was conducted in math and language activities for 6 and 7 years old children. The researcher explored what happened in collaborative learning in traditional classroom without technology support, and what changed with technology support. And the result of the research, MCSCL solved the characteristics that traditional classroom could not reach, and solved portable, immediately, and other characteristics by mobile devices.

UCSCL MECHANISM

According to the related research, this study purposed a Ubiquitous Computer Supported Collaborative Learning (UCSCL) mechanism that attempted to integrate the multimedia information of digital world and the real world and provided a collaborative discussed environment (see Figure 1). In UCSCL mechanism, we designed an integrated multimedia mobile forum named "StudentPartner" which including web-based system and PDA phone system to implement UCSCL environment. In the digital world (the environment which has desktop and laptop computer), users can use desktop or laptop computers to access, share and upload information and multimedia attached files. Another way, users can use PDA phones to access information and multimedia attached file (word, excel, voice file etc.) offline at traffic or outdoor environment. Besides that, users can use PDA phones to capture image or voice via camera, or recorder and post on the PDA StudentPartner to share these multimedia attached file with other group members. And then, users synchronize the local database to server database while connect the network to achieve consistency of information. At this way, the information of real world will be integrated into digital world.
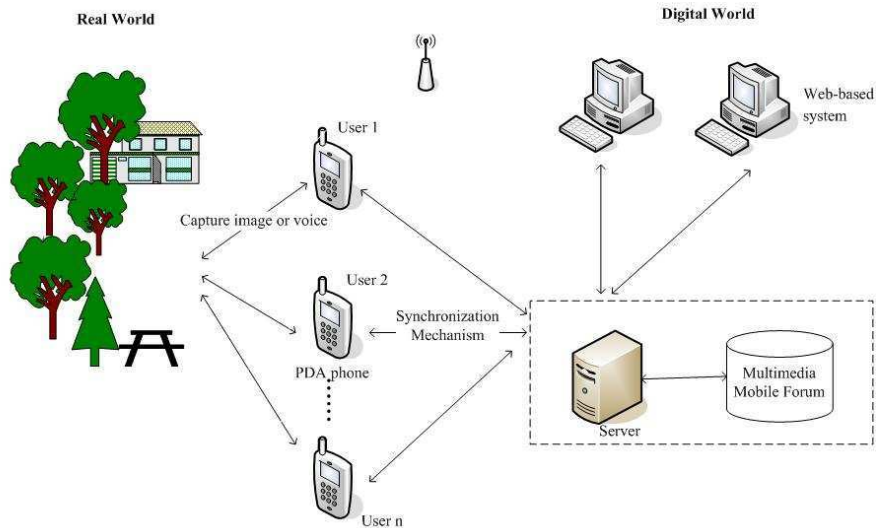
Figure 1.

1. The operations and input of distributed information

The experimental subjects can input data and browsed information in online and offline environments. So the users are able to record and input data anytime, anywhere without influencing other users by distributed environment (Figure 2).
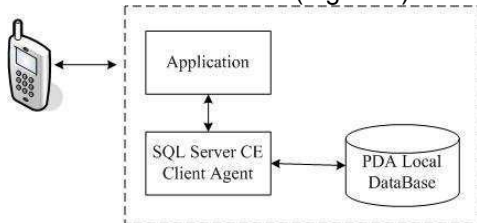
Figure 2. Distributed information operated and inputted

2. The consistency and synchronization of information

The synchronizing agent allows subjects to synchronize their PDA local database with server database when network situation is online. As Figure 3 shows, the mechanism achieves information consistency. And figure 3 indicate that there are many PDA clients but there is only one server. PDA clients can input data in offline environment and when the PDA clients connect to the network, PDA clients synchronize the information (which is recorded in offline environment) to server database and SQL Server CE Agent will synchronize the latest information from server database to local database automatically. If local database is synchronized, users can browse the latest information on PDA and read the contents in anywhere, anytime.
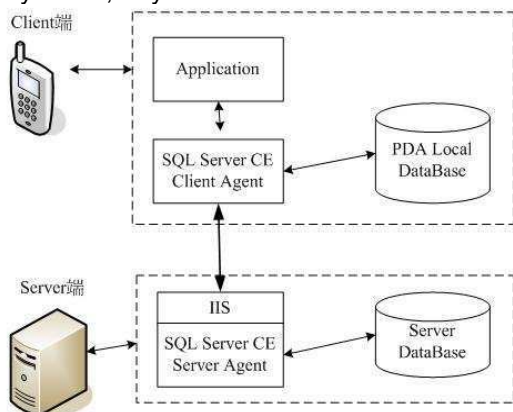
Figure 3. Data synchronizing and consistency

3. Central information administration and central data backup

Information of multimedia mobile forum was public information which all group members could access them. Multimedia mobile forum is recorded the information about personal thesis, sharing reference, sharing multimedia data, and collaborative discussion which group members input. However, incorrect and repeated information will appear. In order to avoid this problem, central information administration is

adopted. Administrator is responsible for correcting, deleting and inserting the forum content in server database. In other words, when incorrect information is inputted, course administrator supervise and guarantee the correctness and consistency of the forum content with deleting and correcting the forum content in the server database. Central information administration is indicated as figure 4.

The server database backup all data (including personal thesis, sharing reference, sharing multimedia data, collaborative discussion and peer messages) simultaneously. It's very important that provide PDA clients database backup and recovery because the eletrical power of PDA was less than one week. PDA users sometimes forgot to recharge and the softwares and data stored in PDA was lost so those uses must reinstall the system and recovey the data. When battery power ran out, or a StudentPartner system was lost, central information management and central information recovery is ensured information would not be lost.
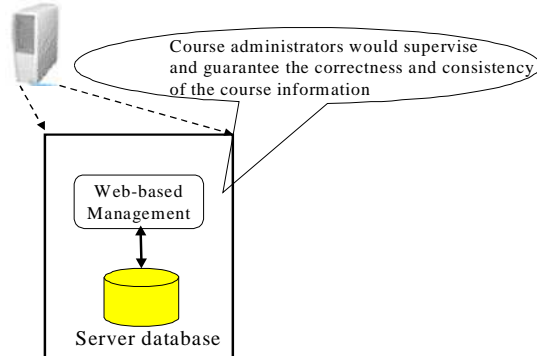
Figure 4. Central information administration

4. Email push mechanism

When the system detect the new content input to StudentPartner, the email push system automatically sent a mail to notice learners that there is a new content or message on the forum and remind learners of viewing content. This mechanism allows learners have more participation in this forum, and would not miss any content messages which they concern.

RESEARCH GOALS

This research attempts to purpose a UCSCL mechanism to facilitate collaborative discussion and collaborative research through a multimedia mobile forum. The investigation therefore focuses on the following goals:

1. Discuss the impact factors of learners' usage with the StudentPartner system.
2. Discuss the impact on system usage (including Web and PDA) when email push mechanism notice learners?
3. Discuss the impact of system usage between PDA StudentPartner and Web-based StudentPartner

EXPERIMENTAL METHOD

Experimental subjects

The subjects are 13 people who are postgraduates or professor the experimental course is one seminar for research purpose (4 female and 9 male). The mobile forum has several discussion topics, including mobile learning, annotation, web 3D, communication and human-computer interaction and public information. Each discussion topic has its own team members including one professor and at least two postgraduates, and they study together and have regular meeting each week.

The experimental period was performed from 2006/12 to 2007/5. In the research, each team will have a team meeting every week, and the meeting will be presented by the postgraduate student to discuss personal research primary. There is also a meeting of whole group. In the every presentation, the presenter will be asked to upload the content of presentation to forum (including PDF file and the PPT file). Therefore, researcher will analyze the data stored on the forum, including the usage of desktop computers and PDA phone.

Experimental process
The research is described below. The first week of experiment detail introduced how to use the PDA StudentPartner and Web-based StudentPartner, and allowed students familiar with the system and process.
In the experiment, research assisted users all the operating problems of StudentPartner installation, database recovery, wireless connectivity, and other hardware configuration which minimum might affect students using the system factors. In addition, during the experiment, professor would continue encourage and urge students to use StudentPartner system. Eventually, upon completion of the experiment, researcher collected and analyzed the data recorded database to understand the actual usage conditions of students. After that, students would be asked to complete a questionnaire and interview.

Experimental restriction
Due to budget considerations, we were unable to purchase 13 PDA phones. Therefore, we only purchased 5 ASUS P525 PDA phones for the students to experiment. And the other users used the old pure PDAs or their personal pure PDA. Moreover, in the experiment process, teacher just encouraged the students to enhance their motivation to learn, not forced students to use the StudentPartner.

RESEARCH TOOLS
The research tool in this study is StudentPartner, and the system is divided into Web-based system, email push system, and PDA phone system. The description as follows：

StudentPartner System – Web-based System
The web-based system of StudentPartner is provided students to browse, publish and reply the information, including personal thesis, sharing reference, sharing multimedia data, and collaborative discussion (see figure 5).

Figure 5. The snapshot of Web-based system

Email Push System
The email push system automatically send the mail to notice learners that there is a new content or message on the mobile forum which is inputted via web-based system or PDA phone system and remind learners of viewing content. The form of sent email include message sender, message subject, message date, and a hyperlink linking to web-based mobile forum to see the message content.

StudentPartner System – PDA Phone System
The PDA phone system of StudentPartner is provided students to browse the information, publish and reply the new inform and share multimedia attached file (word, excel, video, audio file etc) in offline environment (see figure 6). And then, students synchronize the local database to server database to achieve consistency of information when network connection is available.
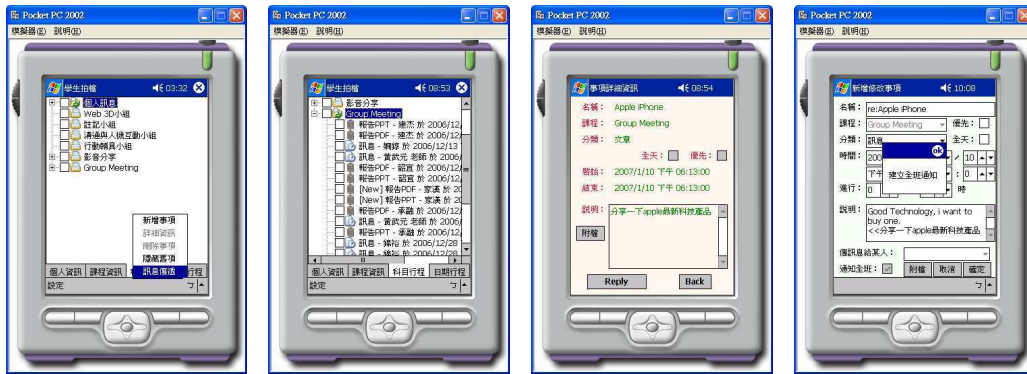
Figure 6. The snapshot of PDA Phone System

FINDINGS AND DISCUSSIONS

In this section, researcher analyzed the data recorded in the StudentPartner database and questionnaire to find some interesting finding. Students' acceptance and attitude of UCSCL mechanism was measured by the questionnaire. The questionnaire comprised Likert scales of 1 to 7.

The impact factors of learners' usage with the StudentPartner system

Figure7 showed that student's usage in StudentPartner (including Web-based StudentPartner and PDA StudentPartner) during the experiment period.
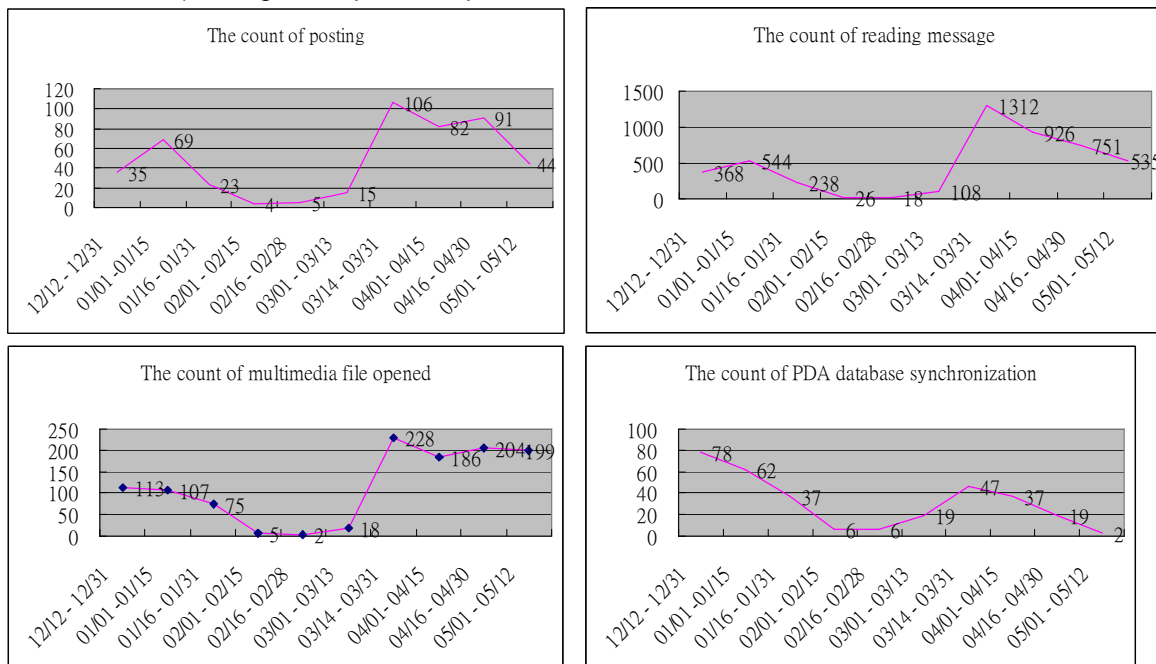
Figure 7. The statistical chart of student's usage in StudentPartner

From figure 7, the period of StudentPartner usage could be divided into four phases. The phase 1 was started in 12/12 and ended in 1/15. The student's usage in StudentPartner was increased because of users' novelty and curiosity and in this phase they would use StudentPartner more often. On the other hand, teacher encouraged and promoted the students to use StudentPartner continuously, and that would motivate students and had more patience to use StudentPartner. The period in 2/1 to 2/28, was the second phase, each part of student's usage was decreased due to winter vacation. There was no group meeting and private meeting and no class, and resulted in reducing use of StudentPartner. The third phase was started in 3/14, and email push mechanism was started in this phase. Each part of student's usage was increased obviously because of email push mechanism probably. Besides that, this phase was the period of the student's thesis writing of second-year of graduate school, and the message published would be grown up significantly. And the forth phase, was the last one month in the

experiment period, the students' usage of StudentPartner was decreased because of the end of experiment.

THE IMPACT OF PUSH MECHANISM ON SYSTEM USAGE

Table 1 shows the impact of students' usage in the StudentPartner (including Web-based StudentPartner and PDA StudentPartner) before and after email push mechanism practicing (started at 3/14). The statistics is average of usage for every person per half month.

The usage of Web-based StudentPartner	Web-based StudentPartner		PDA StudentPartner	
	Before	After	Before	After
The count of posting	1.37	5	0.33	0
The count of reading message	11.67	34	5.03	1.38
The count of attached file opened	1.86	6	2.24	0.81
The count of database synchronization			2.67	1.21

Table 1. The impact of students' usage in the PDA and Web-based StudentPartner while email push mechanism practicing.

Table 1 indicates that the students' usage of web-based StudentPartner was increased significantly no matter in the count of posting, the count of reading message, and the count of file opened. Besides that, the count of posting of PDA StudentPartner was zero, and that indicated PDA is a suitable device to browse information rather than inputting something. Nevertheless, there was not increased and decreased significantly on the students' usage of PDA StudentPartner while email push mechanism practicing.

The impact of system usage between PDA StudentPartner and Web-based StudentPartner

In this section, researchers analyzed the data recorded in the StudentPartner database and we found some interesting finding in PDA StudentPartner, web-based StudentPartner and between them.

First, with PDA StudentPartner, it was found that there was significant positive correlation between "the count of database synchronization" and "the count of posting" (Pearson Coefficients=.828; p=.000<.05), between "the count of database synchronization" and "the count of reading message" (Pearson Coefficients=.912; p=.000<.05), and between "the count of database synchronization" and "the count of attached file opened" (Pearson Coefficients=.835; p=.000<.05). The result showed that the more the number of database synchronization, the more the count of posting, the count of reading message and the count of file opened would be.

It was found that there was significant positive correlation between "the count of posting" and "the count of reading message" (Pearson Coefficients=.803; p=.001<.05), and between "the count of posting" and "the count of attached file opened" (Pearson Coefficients=.788; p=.001<.05). The result showed that the more the count of reading, the more the count of posting.

Second, with Web-based StudentPartner, it was found the same result that there was significant positive correlation between "the count of posting" and "the count of reading message" (Pearson Coefficients=.884; p=.000<.05), and between "the count of posting" and "the count of attached file opened" (Pearson Coefficients=.820; p=.001<.05). And this phenomenon probably effected by email push mechanism. Email push was provided the hyperlink connected to the content of Web-based StudentPartner, and students would read the content more easily because of convenience hyperlink. Moreover, students read more content and message, and they would reply the message more probably.

And next, between PDA StudentPartner and Web-based StudentPartner, it was found there was significant positive correlation between "the count of posting of PDA" and "the count of posting of Web-based" (Pearson Coefficients=.712; p=.006<.05). It was also found that there was significant positive correlation between "the count of reading message of PDA" and "the count of reading message of Web-based" (Pearson Coefficients=.756; p=.003<.05). The result showed that the more usage of the Web-based, the more usage of PDA StudentPartner. The students that use Web-based StudentPartner more than others will use PDA StudentPartner more often.

CONCLUSIONS

With recent advances in mobile technology, mobile learning is one of the current trends in e-learning or lifelong learning. This research proposed the UCSCL mechanism, its corresponding system, Both PDA and Web-based version StudentPartner, was implemented and one half-year experiment was also conducted to study learning ubiquitously. At the end of the experiment period, researchers collected the data in the database and questionnaire and found some interesting phenomena would impact the usage of StudentPartner system. We will deeply explore the reasons behind these interesting phenomena for future work.

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LEARNING RESOURCE AUTHORING TECHNIQUES IN MOBILE PLATFORM

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ABSTRACT

Education and training provision to mobile terminals is called m-Learning. It allows learning experience to be delivered at the precise place and time when it is required. M-Learning is applicable in academicals, in enterprises, in expert system applications, and in tourism. These applications construct interactive learning experience from digital content. Our research scopes content, which is supported by mobile terminals, synchronized multimedia integrated language (SMIL), adaptive multi-rate wideband audio, 3gpp video, and still image formats such as JPEG, GIF, and PNG. Web-base learning experience on mobile terminal do not provides platform independence and depends significantly of mobile browser, of the terminal itself, and of the learning resource complexity. The learning resource authoring techniques and authoring task obligations are proposed as content adaptation principles to achieve terminal independence.

Keywords
m-Learning, SMIL, learning resource, content authoring

INTRODUCTION

Businesses recognized the benefits of the mobile terminals to increase sales, mobile carriers and content providers prompting the market to respond with a wide set of services. 3G and next-generation converged mobile devices opens new opportunities, adds multiple features to the mobile telecommunications experience. The worldwide market for converged mobile devices topped 80 million units in 2006, up an impressive 42 percent over 2005 shipments. In the fourth quarter of 2006, vendors shipped a total of 23.5 million devices, 33.5 percent more than the same quarter a year ago. It enhances opportunity of m-Learning as part of an integrated global educational strategy and allows learning experiences to be delivered at the precise place and time when they are required. It offers a powerful and practical solution to many learning and training challenges, such as in collaborative projects and fieldwork, as a classroom alternative to books or computers, knowledge distribution for widely dispersed learners, promotional and awareness campaigns, and just-in-time employee training.

Previous Work: The usage of mobile technology in educational has been studied by multiple research projects (Keegan 2002, Daniele et al. 2003, Georgiev et al. 2004, Anderson et al. 2004, Attewell 2005). In the past a lot of effort has been devoted to investigate deployment approaches of mobile learning environments. It is important that their experience concludes any m-Learning deployment as inefficient activity once it begins from scratch. Significant effort is required to implement management of learning experience especially if e-Learning architectures exist and standardized by (IEEE 1484.11.2, SCORM 2004). Previous projects specifies m-Learning environment in terms of learning management processes executed on learning management system (LMS), mobile learner terminals, learning resources and their delivery over cellular network or similar wireless solution.

Our previous research (Kolesnikova 2007) investigates possibility to re-use existed e-Learning infrastructure for m-Learning. Proposed approach allows direct re-usage of LMS architecture developed by IEEE, scopes learner terminal to mobile and smart phones, and denotes distribution media to be Multimedia Messaging Service (MMS) or Packet-Switched Streaming Service (PSS). All these factors require adaptation or possible re-work of content associated with learning resources in order to suite requirements of mobile terminals. The resource adaptation can be carried out in a number of different points in the content life-cycle such as applying adaptation at server-side, in-network, client-side through the usage of additional terminal software layer for content rendering (Attewell 2005), and authoring with device independence principles (IEEE 1484.11.2). The our previous research indicates client-side and authoring as most perspective when once open multimedia technology standardized by 3GPP Forum is accepted as authoring methodology for m-Learning resources.

Author Contribution: This publication interest is focused on the authoring perspective of m-Learning resource adaptation, authoring task obligations and device independence principles, and focuses on the quality of learner experience. The paper also considers open issue highlighted in our previous publication (Kolesnikova 2007) such as communicability problems of Synchronized Multimedia Integration Language (SMIL). Any communicable learning resource is responsible to submit learner interactions to LMS. This is implemented on top of ECMA Script and SOAP messaging software but

mobile SMIL players lack these features. SMIL has definite advantage over any other Web-based content description language since it contains methods for client-side resource adaptation, bandwidth management, and allows synchronizing independent multimedia objects, and rendering of rich multimedia content (voice, video) while browsers requires a special software plug-ins (e.g. Windows Media). SMIL-based learning resources are used in many m-Learning applications. These applications includes components that define different aspects of a content structure, which should be considered at authoring stage. This paper denotes these exclusive m-Learning application specific authoring principles.

LEARNER PERSPECTIVE THROUGH M- LEARNING
In present, the face of learner is different from children to senior citizens to business managers on-the-go. Mobile terminals are likely to be used for entertainment, for business-related purposes, and others services. Mobile learners have immediate context-directed intention to search specific pieces of knowledge that are relevant for them. They are not interesting in length courses and training sessions. The device hardware limitation and nature of mobile environments prevents from absorbing lengthy content. Learners expects from m-Learning interactive learning experience, which is called m-Learning application.

Academicals: M-Learning attempts between basic technological and pedagogical problems. In the past, educational process was constrained within blackboard and the teacher was the main source of knowledge. With the advent of mobile technology the learning concept is a change to the positive size. From a pedagogical perspective, mobile learning supports a new dimension in the educational process: the ability for any-time and any-place learning. M-Learning applications should not replace convenient face-to-face or instructor-led training, but mainly facilitates learning, coaching and related management processes. M-Learning serves teacher-student relationship known as legacy application from e-Learning era. Academicals environment propose the m-Learning as a method that supports learners in different levels of the educational process, e.g. during preparation his examination, reviewing his knowledge. The research on usage of mobile Internet by students (Kolesnikova 2007) supports the m-Learning deployment for academicals. More than 50% of students used mobile connectivity for information searching, entertainment, on-line learning and messaging. Messaging is most popular service among others. Nowadays, mobilized students connect Internet through mobile terminals and consume large amounts of multimedia content at anytime and anywhere.

Enterprises: M-Learning changes the primary context of teacher-student relationship from academicals to enterprises, where application helps workers to meet their job requirements and update their knowledge continually. Improve performance and productivity with m-Learning is one of the main integration into employees training. Mobile learning is a valuable solution for many occupations in non-traditional office environments. Enterprises has the series of temporary workplaces, it may be the nature of a job to requires the worker to move from place to place, as in factory work, package delivery, field service, or the health-care profession. Having the option of m-Learning it allows workers to get into the professional field more quickly or more globally to learn on the job. M-Learning offers variety of tools and activities to improve the employees' skills, either to progress at work or to find new employment.

Expert system: Mobility makes expertise available to decision makers and technicians who need answers quickly, provides expert system applications. Expert system is designed for the population who needs to know everything interesting in a short time. Mobile terminals enable on-demand access to in-depth knowledge of specific subjects. These knowledge-based applications of artificial intelligence have enhanced productivity in business, science, engineering, and military and in a ubiquitous life. This system can be used by anybody interested to study whatever one likes.

Tourism: The usage of mobile devices equipped by location-based services gives possibility to implement location aware application for tourism and traveling (Rabin et al. 2006). This application broadcasts real-time information prepared according to the user's position, and personal interests. Tourists are limited in their activities by queue information, daily opening times and ticket availability. If such information could be collected from one central point, it would allow the visitor to quickly eliminate unsuitable activities. It would be far more convenient to have your whole day planned out for you and updated automatically should any of the circumstances change. The other major problem faced by tourists is knowledge of their surroundings.

M-Learning applications uses a representation of knowledge differently then face-to-face, instructor-led training. Learning resources are learning content in a form of digital content and are assembled to hierarchical structures, which introduce a common approach used by the instructional design community to present the complex relationship of a learning material where each element is loosely depicted as a meaningful learning resource (SCORM 2004). The applications listed above require own learning resource organization that should be considered at authoring. The levels of hierarchy and learning resource granularity are not described by the applications such terms needs to be resolved by content developer. The authoring procedure is supported by (IEEE 1484.11.1) that mandate patterns for content organization: atomic, collection, network, hierarchy and linear. Atomic organization implies that learning experience is constructed of indivisible learning resource. Collection is the set of learning resources without specified relationship between them; learner can only indicates a desire to jump directly to specific learning resource. Network defines relationship between learning resources and do not specify any order of learning experience but it offers choice of related resources in contrast to collection where all resources is available. The hierarchical also known as tree structure defines obvious parent-child relation between learning resources. Finally, the linear organizes learning resources in fully ordered manner, where learner has freedom to choose next or previous learning resource. These content organization patterns are tools used by content developers to authorize m-Learning applications. Content developers are looking on two perspectives in m-Learning: the type of interactive learning experience is called m-Learning application, and the learner terminal context. The learner terminal context is a combination of hardware and software that allows learner to perceive and interact with m-Learning application.

	Content Organization patterns				
	atomic	collection	network	hierarchy	linear
academicals		x	x	x	x
enterprise		x	x	x	x
expert system	x	x	x		
tourism	x	x			

Table 2. Rrecommendations to authoring for content organization patterns in context of quality in m-Learning applications.

Content developers are looking on two perspectives in m-Learning: the type of interactive learning experience is called m-Learning application, and the learner terminal context. The learner terminal context is a combination of hardware and software that allows learner to perceive and interact with m-Learning application.

Learning mobile terminal context

M-Learning applications are useful only if learners can view learning experiences reliably without dependency to their learner terminal context. Previous projects (Keegan 2002, Daniele et al. 2003, Georgiev et al. 2004, Anderson et al. 2004) implements terminal independency through the usage of common web-based technologies, the web-browser, its plug-ins and ECMA Script assumes major responsibilities. It has been denoted by (Attewell 2005, Kolesnikova 2007) that Web-base learning experience on mobile terminal do not provides platform independence and depends significantly of mobile browser, of the terminal itself, and of the learning resource complexity. Alternative solution was proposed by (Kolesnikova 2007) for m-Learning, where SMIL and open multimedia technologies provides appropriate level of platform independence through client-side resource adaptation.

The usage of SMIL affects the learner terminal context, requires component for user interface provision, learning resource rendering, and communication protocols with LMS. Let us consider Fig. 1 that depicts learner terminal in terms of functions (navigation control, renderer, delivery, communication) denoted by (SCORM 2004) and their interaction with LMS through mobile gateway (m-GW). Our previous research investigates possibility to re-use existed LMS architecture developed by IEEE in m-Learning applications. LMS provides their services to m-Learning environment thought m-GW. M-GW is the server side software: servlet or web-server script that adapts IEEE compliant LMS interface to mobile platform. The learner terminal is multimedia enabled mobile or smart phone. During our research, we have used Nokia mobile terminals based on S40 3rd edition and Nokia S60 3rd edition software platforms.

The learner terminal is the primary entry point to choose, subscribe learning experiences and enables the means for learner to indicate the desire to navigate thought learning resources in a particular

manner. These functions are available via user interface (UI) provided by the navigation control. None of existed learning standards specifies implementation principles for UI. We used mobile profile of xHTML to implement UI as a solution for m-Learning applications. UI is developed with device independence recommendation by UAProf and provided by simple web-browser capable of rendering text or images, no needs for ECMA Script support. Navigation control applies to navigation between learning resources, and does not address the ability to define sequencing or navigation within learning resources. However, any learning resource may optionally implement UI for triggering navigation within the resource or outside through anchor element specified by SMIL Basic Linking module.

The navigation control delegates learner interactions to LMS in form of HTTP GET request, where URI points the navigation service on m-GW, and defines navigation event to choose particular learning resource, deliver next or pervious resources in learning experience. LMS handles the request accordingly and delivers learning resource to terminal. The learning resources delivery function has been denoted by (Kolesnikova 2007) and includes MMS or PSS services. MMS encapsulates content associated with learning resource to single multipart object and pushes it to terminal messaging subsystem – inbox. PSS streams content directly from LMS over HTTP for text, still images, and over RTP for video and audio content.

The main terminal function is learning resource renderer. It enables learning experience from delivered learning resources. Modern mobile and smart phones have embedded software for rendering SMIL-based learning resources as well as add-on software is available e.g. Helix Player, InterObject. M-Learning applications classify learning experience to interactivity level required from learner. It should be distinguished active, explosive and mixed experiences. Active learning is supported by content that directly induces productive actions by learner, explosive learning occurs when the learner absorbing the exposed content and mixed strategy is a blend of active and explosive types. Mobile terminal capabilities such as input system, screen resolution and software components limit usage of active learning but provides great ability to deploy explosive and mixed learning where dynamic multimedia content assumes major role. Interactive learning experience is ensured by communicability property that defines the capability of learning resource to transmit information about learner's actions. Communicable resources are responsible tracking of learner's interactions, gather competition status, and communicates them back LMS for performance evaluation and control order of learning resource delivery. For interoperability reasons, LMS describes primary communication interface to be IEEE 1484.11.2. Deployment of learning resource based on IEEE 1484.11.2 assumes availability of ECMA Script and SOAP messaging software. In mobile environments, we cannot guarantee that learner will have terminal with these features especially they integration to SMIL player. Therefore, learning resource communicability is achieved via HTTP GET and POST methods The authoring should take into account that SMIL-based content can only submit data and not able to receive response back.
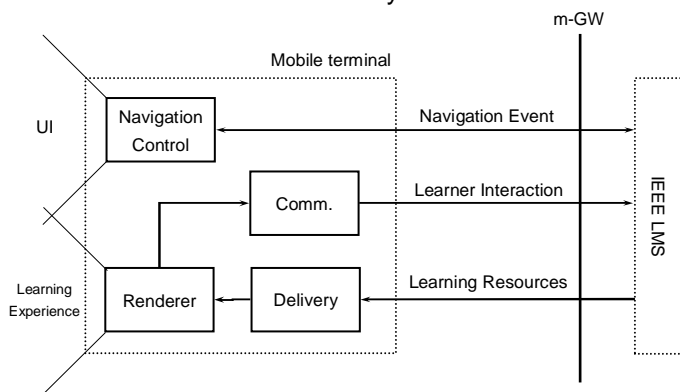
Figure 1. Learner terminal functions.

LEARNING CONTENT AUTHORING IN MOBILE PLATFORM
One of objectives in m-Learning applications is to obtain as much metadata as possible automatically, based on the learner context. This enables targeted retrieval of learning experiences when resources are provided to learners. New requirements for personalized adaptive learning include development of semantic-based and context-aware systems, adaptive to context and learner needs, and exhibits a

seamless interaction with its surroundings. Learning content authoring techniques needs to be considered from multiple points of view: learner behavior, content communicability and authoring tools.

Learner behaviour model in m-Learning
While the learner interacts with m-Learning application it passes through elementary states: registration, personalization, login session, learner attempt, learner session, and communication session. These states are called the temporary model, and developed by IEEE 1484.11.1. Any IEEE complaint LMS supports its temporal model for any interactive learning experience. The chosen authoring methodology for m-Learning experience and software limitations in mobile terminals affects significantly to this model. Specifics of learner behavior in mobile environment should be considered at authoring of learning experience and UI design. The difference of IEEE compliant LMS temporal models and actual mobile learner behavior are shown on the Figure 2.

Learner begins with the registration process within m-Learning application. Many applications defines registration as essential procedure especially if continues tracking of learning activities or learner scoring is required, there is needs to perform billing or authentication. Learner registration allows monitoring the progress through learning experience. Often creation and learner account activation is required in order persist his MSISDN, especially if delivery media is MMS. The registration procedure is the issue of xHTML UI development. UI designer should follow up best practice for mobile Web development presented in (Robin et al. 2006). The registration should not be long, contains not much pages, requires multiple free text input, and account confirmation procedure over e-mail.

M-Learning experience considered successful if it is capable to adapt for learner context and obey individual preferences. Therefore, personalization precedes any learner interaction with learning application. The personalization logically consists of preparatory, educational settings and detection of learner context. The preparatory is learner diagnostic and includes pre-tests, learning-style tests, attitudinal surveys and the gathering of pre-requisite data about the learner experience with mobile terminals and embedded software, many applications verifies job qualification and etc. This data is useful as it can prevent wasteful time on educational process, where the user probably already knows the material. It also allows shaping the learning experience towards that particular learner. The education setting is indented to gather learner essential requirements for educational process. The main steps are familiarization factors with learner's language skills, knowledge on the subjects, experiences and practices, competences, interest, goals, previous activity, and agenda. Finally, m-Learning environment should be able to detect learner contexts such as location and time information, capabilities of learner terminal since learner terminal features might evolve depends on the context. Similar to the registration procedure, m-Learning implements personalization as xHTML-base UI and same practice to optimize UI for mobile terminal should be used. Often registration and personalization are implemented as single multi-page registration form. However, learner context discovery operation needs to be automated by m-GW, based on principles of HTTP content negotiation, on HTTP headers to identify terminal profile, or on UAProf solutions.
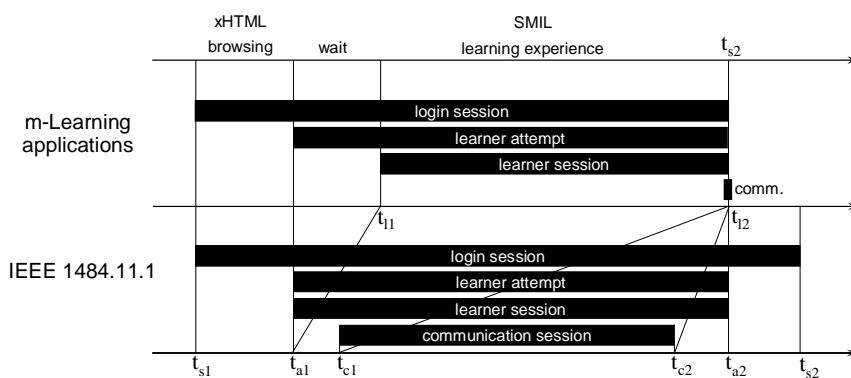
Figure 2. Learner behaviour model.

Registration and personalization are preconditions for actual learning, some m-Learning applications omits these steps to enable easy on-the-go access for learning experience. Any learner interaction with m-Learning application begins with login session. The login session is defined as period of time during

which a learner is acknowledged by the LMS and m-GW. The session remains active when a learner begins a communication with environment at time t_{s1} until he terminates it at time t_{s2}. M-GW identifies t_{s1} when terminal navigation control function issues the first HTTP GET request to fetch instance of xHTML UI. Nature of mobile terminals does not allow m-GW to uniquely recognize session over at t_{s2} time. The gateway detects login session termination automatically based on his internal states, e.g. session time out is over, learner attempt is over or learner instantiates a new session.

Mobile learning experience is built of learner attempts. The attempt is denoted as tracked effort by a learner to satisfy learning objectives and requirements. The attempt is started at time t_{a1}, when learning activity is identified. The attempt is over at time t_{a2}, when objectives are met, in other words, learner has got learner experience and his interactions, and scores has recorded by LMS.

For non-communicable learning experience, it is denoted in (SCORM 2004) that learner attempt ends when the resource is taken away. Mobile terminal renderer function does not provide tools for m-GW to detect time when learning resource is withdrawn from the learner. Therefore, m-GW should inform LMS that learner attempt is over immediately when learning resource is successfully delivered to learner terminal.

Learner attempt spans a learning session. The learner session is depicted as time interval while learner interacts with learning resource, obtains learning experience. The learner session starts once the learner will be engaged with a learning resource and content has been launched in terminal renderer at time t_{l1}. IEEE compliant LMS do not distinguish among t_{l1} and t_{a1}, it defines learning resource launch as instant operation, which is an incontestable fact with bandwidth capacity of fixed networks. Wireless and cellular networks have a measurably high latency, which leads to long retrieval time, especially for lengthy content. Simultaneously, mobile learner terminals implements navigation control and renderer functions as different software components: navigation is held through web-browser, renderer – SMIL player. For example, this problem is extremely visible in MMS delivery scenario. Learner initiates login session and triggers attempt through xHTML UI but learning resource is delivered to terminal inbox as MMS message. Learner needs explicitly instruct terminal messaging component to render the message content. These factors bring visible latency between t_{l1} and t_{a1} that should be considered on m-GW.

The learner session ends at time t_{l2} when learner finishes interactions with learning experience and corresponding learning resource are withdrawn. The learner session can have normal termination when learner fulfils learning objectives and requirement. Learner can also fail to meet objectives, abnormal situation occurs in network, or software crash. Termination of learner session leads termination of learner attempt only if the session ends to normal state. Failure of learning session will suspend attempt until learner successfully passes through learning experience again and again.

Previous section was mentioned that interactive learning experiences is constructed from communicable learning resources that are responsible tracking of learner's interactions, gather completion status, and communicates them back LMS for performance evaluation and control order of learning resource delivery. The active connection between content object and LMS is held within communication session, started when a new attempt begins and resource is launched on the learner terminal. IEEE compliant LMS assumes that communication session is implemented through IEEE 1484.11.2 API. Any communicable learning resource starts the communication session at time t_{c1} by calling "initialize" method and terminates as time at t_{c2} via "terminate" method. In m-Learning applications m-GW adapts this IEEE 1484.11.2 interface to mobile platform. It makes essential difference to communication session timeline. IEEE 1484.11.2 compliant learning resource communicates within the learning session. On mobile platform, learning resource starts communication at learner's discretion when learning session is over. M-Learning applications utilize SMIL Basic Linking Module to achieve learning resource communicability. At the end of learner session the learning resource supplies HTTP/GET request. This approach limits learning communication to simplex model where resources submit information about learner interactions and leads a communication session to be instant operation where t_{c1} equals to t_{c2} and equals t_{l2} termination time of learner session.

Data Model Element	Implement. approach				Applications				Description
	HTTP GET	HTTP POST	SMIL (in-net)	xHTML UI	academicals	enterprise	expert system	tourism	
Comments From Learner		x			x	x			Resource writes data to LMS via xHTML form.
Comments From LMS				x	x	x	x	x	Contains comments and annotations, shown as before or after learning session
Completion Status	x				x	x			Indicates where the learner has completed the experience.
Completion Threshold			x		x	x			Measures the learner progress, content authoring issue via presentation timeline
Credit				x	x				Indicates where learner will be credited
Entry				x	x	x	x	x	Amount of learner interaction with the resource
Exit	x				x	x	x	x	How or why learner terminates the session
Interaction		x			x	x			Resource writes data to LMS via xHTML form, used for assessment, quizzes, etc.
Learner Id				x	x	x	x	x	Identifies a learner
Learner Name				x	x	x	x	x	Learner name
Learner Preferences			x	x	x	x	x	x	Impl. as SMIL Content Control, UAProf, and HTTP negotiation
Location			x		x	x	x	x	Learning resource location
Maximum Time Allowed			x		x	x			Maximum time allowed for learning resource
Mode				x	x	x			Identifies a mode for resource: pre-test, evaluation, etc.
Objectives				x	x	x			Objectives, in m-Learning impl. as read-only for learner.
Progress measure	x		x		x	x			Measures the progress the learner has made.
Scaled parsing score	x								Identifies scaled learner score
Score	x				x	x			Identifies learner score
Session Time	x				x	x			Identifies the amount of time learner spend in the current learning session
Success status			x		x	x			Indicates, where the learner has master the resource
Time limit action			x		x	x			Indicates the action when maximum time is elapsed
Total time			x		x	x			Total time for learning experience

Table 2. IEEE 1484.11.1 data model variables, usage in m-Learning application, and implementation approaches.

Communicability in m-Learning resources

Interactive learning experience is built from communicable learning resources. Any communicable learning resource is responsible to transmit information about learner's actions to LMS. For interoperability reasons, LMS assumes the usage of ECMA Scripts and SOAP messaging for communication. The information about learner's action is defined as IEEE 1484.11.1 data model and must be also supported by any m-Learning resources to ensure interoperability across LMS from different vendors. The data model provides variables to communicate learner progress, the resource writes data to LMS, to control learner session timeline, and to obtain learning experience metadata, the resource reads data from LMS. The read and write access to data model variables is held within the communication session, which is initiated and terminated by learning resource.

Previous sections conclude that SMIL-based learning resource uses Basic Linking Module and HTTP GET methods to achieve communicability. Any communicable SMIL presentation utilizes anchor element to write data model variable. In general, this element allows learner to access any networks resource identified by URI. Same approach is applicable to ensure communicability in m-Learning scenario, m-GW implements a service that access data model variables to LMS via IEEE 1484.11.2 compliant interface. URI defines the network path of this m-GW service and contains list of data model variables in dot-notation and values for them. SMIL player is not capable to automatically activate anchor element, learner action is required.

At learner discretion, the player supplies URI to web browser, which triggers HTTP GET request to m-GW. The gateway service writes data model variables to LMS. SMIL players cannot provide possibility to read data model variables but m-GW can read data model variables and inform learner about its status as xHTML content with the response on GET request. In some m-Learning application, xHTML carried within the response provides additional interaction, e.g. assignment, quiz that is implemented as HTTP POST method to m-GW. Applications should avoid free text input due to input system limitation, instead selection lists, radio buttons and other control that do not requires typing is used.

IEEE 1484.11.1 defines subset of data variables that guides learner session (e.g. maximum time allowed to experience the resource). Learning resource must read them before learner session is started. We implements this feature thought in-network resource adaptation, m-GW reads these variables from LMS and makes corresponding changes to SMIL presentation timeline before delivery.

The IEEE 1484.11.1 data model has been developed from pedagogical perspective. It should be supported by learning resources used for academicals and enterprise m-Learning applications. Some of the data model variables are useful in expert and tourism applications but it is optionally left for content developer decision.

Authoring tools
M-Learning applications build learning experience from digital content. The term digital content is a broad range, including discrete media types as still images, text, and vector graphic, as well as continuous media types that are intrinsically time-based, such as video, audio and animation, Java games, Web 2.0 media boards, Web document, and Flash. Our research scopes SMIL as authoring language to depict learning experiences. SMIL is XML-based markup language, which allows content providers to describe of the spatial layout and temporal behavior of a presentation. It provides various markup elements and attributes for control runtime content choice and content delivery, for positioning of digital content on the visual rendering surface, for coordination and synchronization the presentation over timeline, and for inclusion of digital content.

M-Learning solutions are useful only if learners can view this digital content reliably. Therefore, m-Learning solution provider requires to utilize content supported by mobile terminals. The best result can be achieved if rendering of content is supported by embedded software supplied within the terminals. The previous publication (Kolesnikova 2007) studies the content types suitable to build solid m-Learning experience. Textual content is plain\text media files, still images are image/png, image/gif and image/jpeg, voice and music is encoded by adaptive multi-rate (AMR) codec to audio/amr or audio/amr-wb files, and video is video/3gpp.

The authoring procedure needs to consider variable display resolution of mobile terminals. It varies up to half-VGA and further, the current trend is QVGA (Forum Nokia). Therefore, non-scalable digital content should be developed to suite all resolutions or needs to be scaled at runtime for particular terminal. Modern terminal supports flexible display geometry by changing portrait to landscape mode at learner discretion. Usually, aspect ratio of portrait and landscape geometries differ each other (e.g. QVGA-portrait is 0.75, QVGA-landscape is 1.3). Let us consider the region R corresponds to portrait geometry of terminal display, region R´ is the rotate projection of R by 90 degree – landscape resolution. It is not possible to fit region R to R´ without cropping height, the R´ width needs to be cropped to fit R. The intersection of regions R´ and R denotes area A, which fits best to landscape and portrait layouts. Any non-scalable still images and video content do not loose quality if its dimension less or equal to area A while display geometry is changed. The dimension of area A needs to be denoted in relative values to suite multiple resolutions. The dimension of A relatively to region R and R´ is calculated by formula (1)

and corresponds to (0.75, 1), (1, 0.75) for QVGA dimension. Sub-regions besides area A still used for rendering learning content but they location depends on display orientation.

$$A_R = \left(\frac{R'_h}{R_h} \quad 1 \right) \quad A_{R'} = \left(1 \quad \frac{R_w}{R'_w} \right) \qquad (1)$$

Wireless and cellular network have a measurable high latency, which leads to long retrieval time, especially for lengthy content. Mobile data communication cost money, where learners are charged by carrier for used bandwidth. Any digital content used in SMIL presentation need consider possibility of delivering over MMS, where message size is limited to 300Kb. The lengthy content also affect to quality of learning experience, especially if learner observes delays due to images scaling or requires constant scrolling to view text.

M-Learning applications utilizes AMR compression scheme for voice and audio. This scheme is specially optimized for speech coding and defined by 3GPP Forum as standard solution for mobile terminals. In our research we used AMR-WB codec that provides excellent speech quality due to wider speech bandwidth of 50–7000 Hz compared to others. AMR-WB operates with various bit rates: 6.60, 8.85, 12.65, 14.25, 15.85, 18.25, 19.85, 23.05 and 23.85 kbit/s. The lowest bit rate providing excellent speech quality in a clean environment is 12.65 kbit/s, higher bit rates are useful in background noise conditions. Also lower bit rates of 6.60 and 8.85 provide reasonable quality especially if compared to narrow band codec.

SMIL players allow authoring to utilize PNG, GIF and JPEG files for graphical content. JPEG is most suitable format for photographs, painting of realistic scenes with smooth variations of tone and color. JPEG produces smaller files than GIF or PNG for photo-like images since it uses a lossy compression. PNG is a choice for images that contain text, line art, or other images with sharp transitions, these objects do not transform well into the frequency domain. Like a PNG, GIF are suitable used for sharp-edged line art with a limited number of colors but it takes advantage of small animations and low resolution film clips. The main GIF limitation is color pallet, it supports formation to 256 colors.
SMIL has definite advantage over any other content description language since it allows synchronizing independent multimedia objects, and rendering video content. SMIL player implementations on mobile and smart phone allow learning resource authoring to use video/3gpp. 3GP is a simplified version of the MPEG-4 Part 14 (MP4) container format designed to decrease storage and bandwidth requirements in order to accommodate mobile phones. It stores video streams as MPEG-4 Part 2 or H.263 or MPEG-4 Part 10 (AVC/H.264), and audio streams as AMR. It operates with various frame-per-second rates from 0.5 to maximum 15 fps and supports QCIF and sub-QCIF resolutions.

Content authoring procedure for mobile terminal is time consuming task where most effort goes to testing and verification activity. This effort can be minimized with help of special authoring tools, many device manufactures provides such tools for 3rd party developer. During our research, we have used mobile terminals from Nokia to make the final verification on hardware platform. Primary authorization and testing was held on PC platform with tools supplied by Forum Nokia. We have used Nokia Multimedia Converter 2.0 to produce video and audio content in 3GP and AMR-WB formats. Developer's Suite for MMS 1.1 allows us to encapsulate content associated with learning resource to single multipart object and pushes it to terminal SDK for verification. Finally, S60 and S40 software platform terminal SDKs were used to ensure desired look and feel of learning resources.

CONCLUSION
M-Learning is depicted as part of an integrated global educational strategy and allows learning experiences to be delivered at the precise place and time when they are required. M-Learning applications serves teacher-student relationship known as academicals learning, enables enterprise employee to meet their job requirements, makes expertise available on-the-go through expert system applications and offers new dimension in tourism. M-Learning applications are useful only if learners can view learning experiences reliably without dependency to their learner terminal context. The learner terminal context is a combination of hardware and software that allows learner to perceive and interact with learning experience.

Learning content authoring techniques needs to be considered from multiple points of view: learner behavior, content communicability and authoring tools. Software limitation and mobile environment affects significantly to learner behavior that differs from the IEEE 1484.11.1 behavior. These specifics of

learner behavior in mobile environment should be considered at authoring of learning experience. Content communicability is required to build interactive learning experience. M-Learning applications utilize SMIL Basic Linking Module to achieve learning resource communicability. Content authoring procedure for mobile terminal is time consuming task where most effort goes to testing and verification activity. This effort can be minimized with help of special authoring tools such as terminal SDKs, various multimedia converters and MMS development suites. The financial and technical aspects of m-Learning restrict its worldwide deployment. Nowadays, only medium enterprise can invest to m-Learning solutions.

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SELF-SERVICE EDUCATION: SMARTPHONES AS A CATALYST FOR INFORMAL COLLECTIVE AND INDIVIDUAL LEARNING

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ABSTRACT

A major barrier to the uptake and integration of new technologies in teaching and learning is the lack of personal experience of mobile learning on the part of those involved in teaching and in the preparation of materials and methods of learner support. Our project addresses this by introducing forty academic and support staff to the use of smartphones to support their own learning, within a semi-formal community structure and with a focus on their personal and professional development. We set out to explore whether the smartphone would act as a catalyst, heightening interest in professional development, encouraging exploitation of relevant resources, and promoting dialogue amongst the staff members involved. The paper considers the idea of 'self-service' education, whereby learners are in charge of what they want to learn but may still require some form of support. The peer learning community aspects of the project are foregrounded, consisting of workshops, clubs, a buddy system and online environment. A two-stage process gave us the opportunity to reflect on one group's experience and rethink arrangements before a second group started. We show how fine-tuning a particular professional development opportunity gives insights into the best ways to make use of limited resources.

Author Keywords

Informal learning, community of practice, professional and educational development, smartphones.

INTRODUCTION

Many institutions are at a significant turning point in their exploration of mobile learning. Small-scale pilot projects led by enthusiasts have generated considerable interest. The widespread ownership of mobile phones and personal listening devices, the advent of ultra-portable computers and infiltration of digital culture, have been stirring up debates around the need to take account of learners who may bring with them a new set of tools and expectations. There is growing interest in finding out how mobile devices can be used to enhance teaching, learning and learner support, and to understand how mobile learning can integrate with various aspects of educational provision on an institutional scale rather than in individual classes. However, a major barrier to the uptake and integration of the new technologies in teaching and learning is the lack of personal experience of mobile learning on the part of those involved in teaching, whether dealing with students directly or in the preparation of materials, resources, programmes, courses, and methods of supporting learners. Whilst at first this may seem no different to the situation with other new technologies, we would argue that mobile learning is different. The devices are relatively complex tools, due to their multifunctional character and the need for educators to shift into a contextual way of thinking that also embraces the overlap between formal education and everyday uses of personal technologies (Kukulska-Hulme, Traxler & Pettit, 2007; Pettit & Kukulska-Hulme, 2007). Furthermore, the devices are so many and varied that most people's experience is limited to a specific device that they happen to own, which may in any case be outdated or underused.

In this paper we give an account of our attempt to address the lack of hands-on experience at our university by running a project to introduce forty individuals, a mix of academic staff (faculty) and support staff, to the use of mobile devices – specifically, smartphones – to support their own learning. The focus of this project has been on individuals' personal and professional development, but with a view to nurturing their growing understanding of the potential and realities of mobile learning, through a personal experience. The second vital aspect of the project has been their collective learning, since participants have been going through the experience as part of a group – although the extent of their involvement with the group has varied.

The irony of running a relatively small scale project to address issues of rolling out mobile learning on a larger scale is not lost on us – we are describing what will seem like yet another small scale pilot project. However we hope to show that we view our project as a way to observe how fine-tuning a particular professional development opportunity might give insights into the best ways to make use of typically limited resources, and to this end, we designed it as a two-stage process to enable that fine-tuning. We also outline how we envisage that the project will have an impact beyond its current participants and how we plan to extend it in the future.

BACKGROUND

Learning about New Technologies
Practitioner experience with several generations of new technologies means that the issues surrounding the introduction and embedding of new technologies in teaching and learning in post-compulsory education are fairly well understood. In 2001-2, an evaluation of the introduction of a web-based learning environment in a UK university showed that a lack of awareness and knowledge of new technologies was a barrier to teacher involvement and that those who were not 'in the know' were at a disadvantage (Breen, 2001). At that time, technological advances were thought to be occurring so rapidly that it was noted: 'it is often difficult for lecturers within the academy to adequately assess the pedagogical merits before the technology is rushed into use' (Burnett & Meadmore, 2002). This is a situation we recognize just as vividly today. Burnett & Meadmore went on to argue in favour of localized professional development, provided by colleagues with whom rapport has already been established, as offering a more sustainable form of support than centrally organized seminars and workshops. A few years on, how has the landscape altered, if at all? The pressure to keep up with developments in new technologies is often perceived as relentless, not only due to their continuous evolution but also the diversification of available tools and media. What is more, in an unprecedented way, education providers are obliged to take account of electronic resources and tools to which learners already have access, which includes a range of personally chosen web tools and services and personal mobile devices (Conole et al., 2006). Although our current project does not focus exclusively on teaching staff, the conclusion reached by Fisher, Higgins & Loveless (2006) is confirmed by our investigations of relevant background literature:

> We have found that, though there is research-based literature that deals with teacher learning, and a literature base for thinking about learning with digital technologies, there is little that deals directly with our specific focus of 'teachers as learners with digital technologies'. There is very little fundamental research that investigates how teachers might learn with digital technologies. Rather, there seems to be a pervasive assumption that teachers will learn with digital technologies.   (Fisher, Higgins & Loveless, 2006, p.2)

Professional Learning Communities
There have been some well considered responses to the new challenges, harnessing the readiness of many academic and support staff to learn together. Anderson (2002) relates the experiences of a group of staff in tertiary education who participated in informal professional practice groups in order to foster their own professional learning and reduce isolation. Each group, comprising both academic and allied staff, usually met in an informal setting, with the aim of learning by sharing ideas and experience; their conversations were focused on teaching, learning and other organisational matters. Anderson found that people were willing to give their time voluntarily to collaborate with colleagues with whom they would not normally work, providing that they were learning and felt that they had something to contribute.

Miami University took this approach to a more elaborate level by developing a model of a 'faculty (and professional) learning community' or FLC (Cox & Richlin, 2004), defined as a special kind of community of practice (Wenger, 1998). According to the FLC website (2007), the communities have certain characteristics, e.g. they meet for a period of at least 6 months; have voluntary membership; meet at a designated time and in an environment conducive to learning; operate by consensus; energize and empower participants; have the potential to transform institutions into learning organizations, and so on. Faculty learning communities differ from 'action learning sets' (a more established form of professional development) in that the communities are less formal and they include more focus on the social and fun aspects. The leaders of this initiative comment that over the years, one-third of Miami faculty have participated in FLCs, which indicates that the remainder may not wish to do so, because they do not have the time, they do not want to give up their autonomy, or "there has not been a stage in the development of their academic life that calls for community." A similar type of learning community at Wright State University (2007) was established to help faculty effectively implement mobile learning strategies in their learning environments; the community has concentrated on the use of podcasts in teaching and learning.

Initiatives like these, big and small, illustrate an acceptance of informal and voluntary learning, with a degree of structure provided by participation in a community, involving some expectations regarding how the community will operate. The community may be a means to sustain a professional development over

a longer period of time than would be typical when completing a specific training module or programme. The professional learning community is also a way of supporting self-development, and it connects with visions for lifelong learning that include forms of peer support and the opportunity to access learning as and when required.

Self-service Education: Individual or Collective?
In his keynote address to the Educause 2006 conference, the 'chief internet evangelist' at Google, Vint Cerf (2006), drew attention to the new user-oriented paradigms and the emergence of a great deal of 'self-service' provision such as Amazon and Tivo, noting how this is extending to the way people are thinking about education. There is something compelling about the idea of self-service - it is cheaper and faster, more in tune with the way we live today. Subscribing to various online services and to selected types of content has become an integral part of many peoples' lifestyles and working lives. As might be expected, already some have come to realise that they prefer a more traditional, leisurely, or personal form of service – the antithesis of the self-service mindset – but these individuals may be swimming against the current.

The concept of 'self-service' relates well to individuals on-the-go, short of time but generally clear about what products or services they require. The downsides of self-service include a lack of support when a service does not perform as expected and the lack of explicit opportunity to expand one's knowledge or horizons by reference to other learners and their experience. Self-service education may also rely on self-motivation, and some imagination or vision – perhaps a personal development plan. The project we report on in this paper combines some elements of individual learning with the support, ideas and encouragement that a collective enterprise may be able to provide. It is unusual in its focus on a physical (as opposed to online) community of users of mobile devices and our interest in mobile professional and personal development. Clough (2006) has researched online communities of mobile device enthusiasts; and Petersen & Divitini (2005) have written about the relationship of physical and online communities to mobile learning, but there is a lack of research in the intersection of personal, professional development and learning about mobile technology.

AIMS OF THE PROJECT

Hands-on Experience
The key aim of our project has been to give members of staff in our Institute the opportunity to experience handheld learning for themselves, so as to gain a proper understanding of the potential of mobile learning and how it can be realised. In our context, academic authors writing distance course materials are the people who most clearly need to benefit from hands-on experience to enable them to design materials for mobile learning. However, informal interviews with line managers within our academic unit revealed that there was real interest in handheld learning among administrative staff supporting courses and also a general need for all categories of staff to become more aware of how handheld devices may be used in education. Staff could use mobile devices to support their own learning, and it would help them to feel more confident to contribute ideas and follow conversations in various meetings. Although it was known that a few individuals owned PDAs and other devices, and several types of device were available for long-term loan, there had been little opportunity to have shared learning experiences that could be the basis for informed discussion.

Our Institute has extensive experience of introducing colleagues in the university to pedagogical uses of new technologies, recently through award-winning programmes such as 'Introduction to Teaching and Learning Online' and 'Teaching and Learning with Media'. The Institute's Centre for Educational Development has a programme of educational and professional development for colleagues across the university. Staff development (a term that in the UK covers the development of both academic and support staff) became a priority area for the Institute when a senior member of staff was appointed with specific responsibility for staff development. One of the objectives was to promote the understanding and hands-on experience of cutting-edge new technologies, so that the Institute could continue to be effective in supporting the university in this area.

Professional Development
Funding for the project came from one of the university's four 'centres for excellence in teaching and learning'. The centre for excellence in Practice-Based Professional Learning issued a set of funding

criteria, including how learning would be captured, the cost-effectiveness of the project and how it would cross faculty boundaries. We were aiming to build the evidence-base for good practice and to provide opportunities for reflection and for engagement in a community of practice. Our unit would also act as a knowledge broker, enabling others to gain knowledge of existing resources and problems, and to find out who has relevant knowledge. The mobile devices offered an opportunity to capture learning on the go; this was to be complemented by enabling participants to share their learning with others via workshops and learning partnerships. Our preliminary contacts in the Business School and in the Department of Languages indicated that colleagues were very interested in mobile learning.

The starting point for participants would be the identification of their own personal/professional development needs. Currently members of staff are only really required to think about this at their annual appraisal, i.e. once a year, or in some cases even less often. We felt that those moments at work when individuals identify a real gap or need are missed opportunities that get forgotten. There is also no easy way of knowing whether other colleagues have similar needs or issues. By carrying a mobile device dedicated to their personal and professional development, participants would be able to:
a) Capture their own development needs as they arise in context, for example during the execution of a work task, at the end of a meeting, or in conversations with a mentor;
b) Take advantage of another way of accessing existing staff development resources;
c) Share some of their identified needs with others, where there may be benefits from forming learning sets or similar arrangements to address common development issues.
In the initial workshop with participants, we explained what we meant by 'recording or capturing professional and personal development needs', and gave some examples, e.g. needing to improve one's presentation skills, planning which conferences to attend, arranging a secondment, finding a mentor. A number of possible activities were presented, e.g.

- o Over time, make a list of options to pursue, then maybe email the list to a friend or mentor for comment, or prior to a chat

- o When you are in a wifi hotspot on campus and have some spare time, use Google to research a topic of personal interest

- o During a meeting or seminar, make a note of, or look up, a couple of terms or concepts that are new to you

- o Experiment with a new method of note-taking in a meeting where you aren't required to take notes

- o Over time, build up a list of websites, papers and books recommended by colleagues, just for yourself or to share with others

- o Record circumstances that make you upset at work and make time to reflect on them once a week and find solutions

- o Use mobile device capabilities to solve a work-related problem

The capabilities of the selected mobile device (detailed in the next section under 'choice of device') were also listed in the session. Apart from giving this general guidance, we did not ask participants to complete any specific tasks during their 5-month period of use. Our intention was to stimulate them by giving them some ideas at the start, and then leave them to make up their own minds about how they would use their device for personal and professional development. They could also share their ideas with others at the workshop.
We set out to explore whether the mobile device would act as a catalyst, heightening interest in professional development, encouraging exploitation of relevant resources, and promoting dialogue amongst the staff members involved. Through the project we were interested in exploring the following questions:
1. Does using a mobile device actually enable staff to capture their development needs as they arise and what are the benefits of doing so?

2. Do the affordances of the PDA correspond to the specific requirements of capturing development needs, sharing with others, and having convenient access to relevant resources?

The project has been led by two academic members of staff and a Senior Learning and Teaching Technologies Manager. It began in October 2006 and is due to finish in September 2007.

METHODOLOGY

A Two-stage Process

The funding enabled us to purchase sufficient mobile devices to allow a group of 20 people to participate in the project; in the event, we had 40 participants. Participation was on an entirely voluntary basis; an open call invitation by email resulted in forty people coming forward, from all categories of staff. As the number of volunteers greatly exceeded device availability, we decided to stage the project so that two groups of 20 would each have a 5-month stint using the devices: Group A between November 2006 and March 2007, and Group B between April and August 2007. This two-stage solution meant that we could review what had been learnt from the experience of Group A, and make some changes to the design before Group B began their involvement.

The names of volunteers were allocated to the two groups on a random basis but having first been sorted by staff category, so as to ensure a similar distribution between the two groups. We checked that there would be both female and male participants in each group, bearing in mind that in the unit as a whole there are 74 females and 41 males, but we did not aim at a precise ratio. There were 16 females and 4 males in Group A; 12 females and 8 males in Group B.

Choice of Device

The original funding call specified the projects would use PDAs, as these were thought to be the most appropriate device to support reflective learning in practice-based settings. Our experience with various PDAs on other research projects meant that we could not immediately identify a suitable device – all were known to have considerable limitations in terms of ease of use and flexibility. On the advice of our senior technologist, we considered and eventually selected the Qtek smartphone. On inspection, this device had good visual appeal, it was relatively small and light, and offered several user input options, including an integral slide-out keyboard. The fact that participants could use it as their phone, if they chose to do so, was attractive (although the project did not require them to use the phone function). The cost of this device was not prohibitive; we had ruled out buying a smaller number of very expensive devices that would normally be beyond the reach of staff working in academia and therefore representing an untypical experience for our context. Finally, we were inclined to opt for a device that our technical support specialists had confidence in, since for them, supporting a mobile project of this kind was also a new departure. To increase the flexibility of the device, it was decided to purchase additional memory cards so that resources in the form of video clips could be more easily stored and accessed.

Structure and Data Collection

As the funding award covered the costs of mobile devices only, we have a low-resource project which is making the most of local expertise and is heavily constrained by available staff resource within our unit. This is reflected in the project's design, which must have due regard to these limitations. The research instruments are by necessity fairly simple, but the design has benefited from our experience in educational development, a flexible and responsive approach, and a firm focus on peer learning and participant engagement.

The project has been structured around a number of workshops, three per group: a workshop to introduce the project and the device to participants; one half-way through; and one at the end of their five month stint. In-house instructions on how to set up the Qtek, synchronize it with the PC and connect to the Internet via wifi were developed and tested by the project team as the Qtek manuals are both too detailed and not specific enough in relation to the local context of use. We developed three paper-based questionnaires, to be completed by participants at the start of each workshop. Attendance at the workshops was mandatory, although not all participants have been able to take part, due to competing work priorities and inevitable absences. In those cases, questionnaires have been sent to them individually. The questionnaires contain a mix of multiple-choice responses and open questions requiring written comments. Participants all agreed to include their names on the questionnaires, to enable us to analyse their evolving experience over time.

The workshops include short presentations (e.g. examples of personal and professional development), discussions, problem-sharing, individuals describing how they have used their Qtek, and structured activities to elicit opinions about the advantages and drawbacks of using the device. A technical specialist is available to answer queries. The two workshop leaders take it in turn to make notes and observations during the workshops. The project also includes more informal mechanisms for enabling participants to keep in touch with one another (described below under "Creating a community"), including 'Qtek Clubs'; in cases where the project leaders have attended the club meetings, issues raised there have also been noted. Out of each group of participants, we are also selecting 10 people to interview at the end of their 5-month stint with the Qtek. Interviewees are selected on the basis of a review of their questionnaire responses and any notable contributions in the workshops, with a view to:

    (a) choosing those who have made use of the Qtek in definite or interesting ways, where eliciting more information will help us to document these uses, to share with others as project outcomes;

    (b) ensuring a spread of interviewees across the various categories of staff (academic and support staff) participating in the project.

The two-stage process (described above), our knowledge of the participants, and the diversity of sources of data mean that the project is being carried out in the spirit of 'grounded theory' (Glaser, 1992). One of the outcomes we are aiming at is a model of how the various components of this initiative – participants' personal agendas, device affordances, the community, locations of use, the support structures created, and so on, interact with one another to influence participants' perceptions of what they personally have gained from the experience and how adjusting the components can influence both individual and collective learning. Our point of reference is Kukulska-Hulme's description of the factors impacting on the usability of mobile devices in education (Kukulska-Hulme, 2006).

There is no attempt to make a direct comparison between the experiences of the two groups of participants; the fact that they are not using the devices at the same time, yet they are in the same academic unit, is in itself an important factor that would rule out such a comparison. However, the aims of the project and basic structuring of the two cohorts provide enough continuity to be able to make some statements based on the experience of the project as a whole.

CREATING A LEARNING COMMUNITY

Assumptions about Community
At the start of the project, as project leaders we considered our expectations and assumptions about the project and its participants. Based on our knowledge of colleagues in our unit, where we have worked for a good number of years, we thought that volunteers would tend to be self-motivated and fairly autonomous people, i.e. they would not be too dependent on project leaders and would be willing to experiment. We saw all staff in our unit as capable of innovating, and of using the Qteks in unexpected yet imaginative and effective ways.

At the same time, we thought that participants would want to share their personal and professional development needs with others, perhaps arriving at common issues. A number of assumptions were articulated, specifically in relation to community aspects of the project, including the following:

    o The volunteers would see themselves as like-minded people who are interested in new technology and are positively disposed towards helping one another;

    o They would already share the unit's ethos of 'knowledge brokering', i.e. they would be willing to share their growing expertise with other people, especially colleagues outside the unit;

    o Those who had previously used PDAs or smartphones (and maybe had their own device) would be willing to share relevant expertise with those who were less experienced, which might entail giving some of their time;

    o A community of users would make it easier for staff to engage with the project initially and also to keep going longer term;

    o The provision of an online environment is nowadays expected as a means towards community building, therefore this would need to be provided - but participants would expect face-to-face contact as well.

These assumptions were not discussed with project participants. However, two key points were made at the first workshop: 'The Qtek device is a tool that can help you think about, record, share and act on your personal and professional development needs, as and when they arise', and 'Being part of a group of volunteers may help.'

Reflecting on our assumptions during the course of this project, two issues have gained prominence: first, work-related time pressures that stand in the way of people giving their time freely to others, and second, the issue of whether providing an online environment for sharing is the right thing to do. The latter issue arose as the environment we provided – a wiki – failed to be used, and in line with a developing debate in the field of learning technology where it is being suggested that learners might prefer to use whatever tools they know and use already. The wiki is further discussed in the next section. We were also aware that as project leaders we valued learner autonomy and self-motivation, as well as knowledge sharing, learning by doing, reflective practice and peer support - values and approaches originating in our long-term involvement in teaching and course development on the unit's online Masters programme. These values would be held in common with some of the project participants, but the extent of it could not be known. We tried to make these values explicit to all participants in a short presentation in the first workshop, and reinforce them in the way we conducted the project, recognizing however that accepting or internalizing values may be a relatively long and complex process. There would also be an unknown relationship with other existing individual and collective values. Internalizing and acting on certain chosen values is one of the fundamental aims of *education*, but how much of it is attainable in the space of a 5-month semi-formal group experience with technology? We considered this an interesting question which we would not attempt to answer in this project.

Means of Sustaining Community

In addition to the three workshops per group, and knowing that some, but perhaps not all, participants would be able to talk with others about their Qtek (e.g. because they shared offices with colleagues), two other semi-formal means of staying in touch were offered to the participants. The main one was an encouragement to take part in "Qtek Clubs", which would be run by, and for the benefit of, project participants. These have taken place every few weeks at lunchtimes, in a quiet coffee lounge within the unit, and have been attended by between 5 and 8 people (out of 20) on each occasion. There is no specified programme for these short club meetings, only a suggestion that chatting about topics of common interest and self-help with technical issues might be appropriate. With Group B, more encouragement was given to the club activity by making sure that meeting dates were properly arranged and communicated by email, and suggesting some topics that had surfaced among participants and could be a useful focal point for the meeting.

The second semi-formal means of maintaining community was the provision of an online environment; for Group A, we considered using the university's Knowledge Network, but in 2006 this still had limited facilities for collaboration. Wikis were talked about in the unit but only used by a minority of staff for specific purposes. It seemed a good moment to try this method of collaborating. The idea behind the project wiki was that it would enable participants to communicate conveniently between workshops, and it would be a place to share ideas and resources. Use of the wiki was presented as optional, but to get things started, one of the project leaders put up a message in the wiki, accompanied by a photograph taken with the Qtek. Due to unforeseen circumstances, the wiki was not made available until a few weeks into the project; this, along with other factors, may have contributed to it not being used.

Finally, we made some tentative suggestions that participants could pair up with a 'buddy' – another person from their group – as this would be someone they could turn to if they had problems or wanted to share ideas. This was taken up by only a few participants. We are aware that one particularly effective pair consisted of someone who had previous experience with PDAs and was an enthusiastic user, and someone who was a keen beginner.

PARTICIPANT EXPERIENCES

In this section, we report selected findings from the experience of the first group, concentrating on (a) community, interaction and support aspects of their experience, and (b) the Qtek's role in personal and professional development.

Community, interaction and support

Participants were asked to rank their preferred method of 'getting to know a new IT device initially' and gave the following responses: ('1' = method liked most, down to '5' for the least liked method).

Method	Participant's ranking
Try it and see	11111 222 3333 4444 5555
Follow an instruction sheet	111111111 22 33333 4444
Read the manual ***	1 22 3333333 444 5555555
Have friends/colleagues help you or do it with you	1 22222 333 4444444 555 *
Have someone experienced show you exactly what to do	111 2222222 3 44 555555 *

one respondent could not decide how to rank these methods.

A subsequent question asking about the preferred ways of getting to know the IT device *over a longer period of time*, showed that participants would prefer even more strongly to keep trying things out to see how they work. Very few gave a high ranking to preferring friends, colleagues, or someone experienced to help them or show them what to do. This supports our assumption that volunteers would tend to be self-motivated and fairly autonomous people. Responses in the second and third questionnaires (second and third workshops) confirmed that participants were following their stated preference by using primarily a 'try it and see' approach, although up to 10 participants had asked a friend or colleague for help.

When asked in the first questionnaire, "Do you imagine yourself being involved in helping other staff in the project?", half of the participants did not see themselves in this way:

Yes I'd like to do that if I have time*	I don't really see myself doing that but you never know	No, I wouldn't want to, or I don't have time
8	10	2

one respondent added, 'YES if I could be of help & have the time'.

The first questionnaire also had a section on 'learning as a group of volunteers'. Participants were asked how much they would expect to learn about the Qtek device from other members of the group, and to indicate the response closest to their position. Most were reasonably hopeful about how much they would learn:

A great deal	A certain amount	Probably very little
6	12*	2

*One respondent commented: ''*Depending on how communication between all of us is supported – is there an email list, online forum*?'

In the second questionnaire, when asked how much if anything they had learned about the Qtek from other members of the group, only one person had learnt 'a great deal', 7 considered they had learnt 'a certain amount', and the remainder very little or nothing. At this stage, a comment from one participant showed that this person was reflecting on their need for support:: *"I tried to buddy up with someone but failed to schedule in regular meetings. Buddying up would have helped me get much more out of the experience – providing a sharing of information but also a 'protected' space for me to learn and put this kind of learning in my schedule."*

Those who attended the Qtek Clubs were positive about their usefulness: comments included mention of fun, confidence-building, encouragement, problem-sharing and improving understanding. Lack of time and conflicts with other commitments were the main stated reasons for not attending.

When asked at the end of the project to describe the most valuable communication they had had with colleagues about using the Qtek for personal/professional development, participants mentioned the workshops, Qtek club sessions, and speaking to the project team. Comments included '*Comparing the ways different people are using it and what each person has learnt – this presents information about the Qtek in a more digestible way than reading the manual'; 'Using text (and keyboard!) to get messages to colleagues';* and *'initial chats and enthusiasm'.*

Personal and professional development with the Qtek

Responses in the questionnaires indicate that for all participants, wanting to interact more with other members of the academic unit was one of the reasons for having volunteered to take part in the project, although for most this was not the strongest reason. Other reasons for joining the project included wanting to:

  o make their work practices more efficient

  o communicate with their work PC from wherever they are

- o see if the Qtek is useful in terms of orientation (new member of staff)

- o improve on an unsatisfactory previous experience of using a PDA

- o upgrade their device - the Qtek being a better device than one owned currently

One participant had a wider ambition expressed as "hoping to encourage wider use of such devices in the Open University".

When asked about their current personal and professional development, all except one participant agreed with the statement: 'I often get an idea for something work-related I'd like to learn, or some personal development I'd like to do'. This indicated to us that they were positively disposed towards personal and professional development. Participants listed many ideas of how the Qtek would fit into their existing work patterns and habits, and how it might help their development, for example:

- o making time management activities easier, 'mobile access to help me use time best'

- o instant searching, instant jotting, quick emails or calls

- o accessing email and internet when not in the office

- o greater integration of off-site and on-site notes, diary entries and to-dos

- o an alerting/reminding system ('as long as I remember to charge it on a daily basis and take it along with me everywhere')

- o in meetings, for meeting records, reminders for meetings

- o 'a mobile, interactive journal'

- o multi-media while travelling

- o improving IT skills and confidence

- o to support writing up of PhD

- o editing documents on the move

- o making greater use of workgroup programmes (e.g. outlook shared diary, task group features), as colleagues become more connected

A large proportion of participants also mentioned that they were not sure about how they would use the Qtek. Most had some ideas but not firm plans for use.

Since the Qtek was to serve as an informal means of capturing development needs, we asked participants whether they already had 'a reliable method for recording and retrieving ideas related to work and/or their personal development'. Just over half agreed that they already had a way of doing this (although only one person *strongly* agreed with this statement). Therefore for over half of the participants, the Qtek might compete with existing methods of recording, whilst for the others it would represent a new opportunity in this respect. Three-quarters agreed that they 'rarely have time to follow up their ideas for work-related or personal development'. We concluded that lack of time could therefore be a factor in whether they realized their plans, despite good intentions and what the device could offer.

At the half-way point (second workshop and questionnaire), it became evident that the calendar function was being used a great deal and was appreciated. Several participants mentioned using the camera, making notes and lists. Pervious habits were sometimes being extended, e.g. carrying documents more regularly than on a previous PDA, extending an existing habit of making lists, sending more text messages than before ('because the transcribe function really suits me'). For some, use of the Qtek proved to be a chance to reflect on how they could be helped by technology and on barriers to technology adoption. At this point, a couple of people said they had given up using the Qtek, as being mainly office-based they could not see any real advantages over their desktop PC.

By the end of the 5-month stint, only 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, and taking photos in a 'do-it-yourself' store to record measurements for projects. Reflecting on their overall experience, just over half of the participants agreed that there were times when they had wanted more support in the form of structured learning activities. A similar proportion could not see the Qtek's relevance to their personal and professional development. A slightly higher proportion found the Qtek to be relevant to their work and their leisure or

entertainment. Almost half did not like the 'look and feel' of the device; various usability issues were mentioned, such as preferring a smaller device and finding the device cumbersome for phonecalls. Participants mostly agreed that they had improved their awareness of an important emerging technology. They were divided in their thinking as to whether they were now more aware of opportunities to record and reflect on personal and professional development on an ongoing basis, and similarly divided with regard to whether the Qtek had encouraged them to think imaginatively about applications of new technologies. There were many very positive comments about how pleased people were to have been given the opportunity to use the Qtek.

STARTING AGAIN- THE SECOND COHORT

The second group of participants began their use of the Qtek in April 2007. During March, we reviewed how the first group had progressed and made some changes to the design of Group B's experience. We knew that connecting to the internet would now be more feasible for participants, given that wifi infrastructure had improved in the building since the first cohort started. In-house documentation was amended in order to:

- o encourage users to keep trying if initially they have problems connecting to the internet

- o give advice on connecting to their email account

- o give tips on battery life and wifi (checking the battery; shutting down programs running in the background; identifying whether a wifi connection has been made; selecting the network for wifi)

- o give tips on re-aligning the screen and photo sharing.

For the first workshop, we increased the amount of hands-on practice, and included practice in accessing the internet and the wiki space. We emphasized the importance of buddies, and made sure everyone who wanted a buddy had one; it was suggested that an advantage of having a buddy was that one of the buddy pair could attend Qtek Club and share with the other later. We showed sound recording and sharing photos via OpenStudio, an online environment for photo sharing. Social issues, such as the acceptability of Qtek use in meetings, were raised and discussed.

However, we realized there were still some gaps in our knowledge, e.g. participants asked some questions that could not be answered about multimedia messaging. It also emerged in the session that a couple of Qteks still contained data from previous users, a situation we had sought to avoid by resetting all the Qteks. After the first workshop, we offered an early troubleshooting session in the form of the first Qtek Club two weeks after the first workshop, and created a mail-list for the group to see if this would be used in addition to, or even instead of, the wiki.

CONCLUSIONS

The project has a broad remit encompassing professional development in the use and understanding of new technology as well as an exploration of how a specific mobile device can enable staff to capture their development needs on a continuous basis and share them with others. In this paper, we have considered the design of the project as a whole, particularly how its various support elements contribute in different ways, our underlying assumptions about the community of participants involved, some findings related to their group experiences and personal/professional development, and the way we have been reviewing the design of our project and its progress.

Smartphones are a tool for communication, but in this project they have not been used for direct communication between participants. Cost implications of doing so were the primary reason for not designing the project around communication by smartphone. Instead, the rich capabilities of the device in terms of data capture are being explored. The availability of (free) wifi on site, and the fact that nearly all participants work in the same building, also had a bearing on our choices. The co-location of mobile learners raises interesting issues around the best means of communication between participants, what can be done to promote community and whether people prefer to learn from one another or to try things out on their own. At this stage we can say that a certain amount of peer learning has taken place, and that participants have found the semi-formal support in the shape of workshops, Qtek Clubs and a buddy system helpful and motivating. Perhaps unsurprisingly, the online element (wiki) has not been used to date, although we have yet to see whether the photosharing facility and mail-list fare better.

On the basis of the first group's experience, we expect that the second group of volunteers will benefit from using the Qtek in similar ways. They are likely to use the calendar function to organize their work

and try to be more efficient, and they will probably use the camera. We anticipate that wifi connectivity may still present some problems. Over 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. Participants did not, on the whole, venture into more unfamiliar territory such as voice recording, listening to downloaded recordings or seeking out and viewing video clips. It was interesting to see that possibilities such as reminders and alerts were constrained by human factors ('as long as I remember to charge it on a daily basis and take it along with me everywhere') and it became clear that collaborative activities such as a shared diary would only take off if enough colleagues who normally work together were using the same device. The 'look and feel' of the device, often perceived negatively by the participants, would continue to present a barrier to successful use.

For our academic unit, the smartphones have acted as a catalyst, raising the profile of professional development and promoting dialogue amongst the staff members involved, in the unit more widely and beyond. We are planning to run workshops and similar events to share knowledge and experience with the rest of the university after the end of the project. These will also be a chance to show how the activity of recording development needs could be extended to similar activities for students. Learning partnerships with individuals in other faculties might be offered, subject to the availability of sufficient devices. This will involve staff being put in touch with a willing colleague in another part of the university, so that expertise may be shared more directly on a one-to-one basis. The feasibility of these plans is being assessed as the project develops.

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NEW TECHNOLOGIES, NEW PEDAGOGIES: USING SCENARIOS FOR STAFF DEVELOPMENT WITH MOBILE TECHNOLOGIES

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ABSTRACT

This paper explores the staff development process to engage academics in a Faculty of Education to explore new pedagogies required to incorporate the use of mobile learning technologies in teaching and learning activities with their students. Many staff acknowledged the benefits of active learning to meet the needs of millennial learners. This project sought to address ways to incorporate the everyday technologies these learners are using within the assessment process. The staff development process addressed the need for staff to own and use mobile technology in their professional and personal contexts in order to think differently about engaging their students in pedagogically sound ways. We explore the steps taken in this action learning process as staff members became familiar with smartphones and ipods and examine the development of the perspectives of the academics involved of the affordances these technologies could offer to improve and support student learning. The use of scenarios as part of an action learning process assisted academics to think more broadly about how the devices could support student learning.

INTRODUCTION

As mobile and ubiquitous (anytime, anywhere) computing technologies become an extension of the hands of the millenium generation, how can we use the affordances of such technologies to support learning in the higher education sector? There is much discussion in the literature of the changing needs of next generation students and the challenges faculty face in meeting these needs (Dede, 2005; Moore, Moore, & Fowler, 2005). This paper seeks to explore academic development practice to facilitate the development of innovative pedagogies for teaching in a Faculty of Education that incorporate the use of such technologies in assessment tasks. The purpose is to engage future educators in using the technologies that provide opportunities for them to consider pedagogically sound practices to engage their prospective students (Moore, Moore, & Fowler, 2005). Kukulska-Hulme (2005), in a JISC funded project to map the landscape of mobile technology, warns of the importance for lecturers to become 'device-aware' if they are to use such technologies effectively in their teaching. Whilst acknowledging a wide range of factors will influence institutional policy in the area of mobile technologies, two of the strategies they recommend include:

- "Recognition that mobile and mobile devices are 'personal' and encourage 'ownership' amongst lecturers – easy access to a range of mobile devices will develop familiarity, expertise and confidence.
- Sustained, timely and accessible staff development that addresses lecturers' pedagogic and technical worries; mixing 'just-in-case' with 'just-in-time'." (Kukulska-Hulme, Evans, & Traxler, 2005, p. 8)

Whilst there is a distinct body of research in the field in the area of mobile technologies and devices available and successful pilot studies using these technologies, of significant importance to this research is the need to implement supportive academic development programs that acknowledge the challenges faced by academics. It is not sufficient to support the technology aspects of the use of new devices, we must also consider the impact on the academics involved, especially in considering "the achievement of learning goals and maintain[ing] fidelity with existing beliefs about teaching and learning as [staff] come to terms with an emergent digital pedagogy." (Lloyd & Irvine, 2005, p. 378).

The paper will describe the background to the project and provide an overview of the relevant literature and the methodology used. It will then provide an overview of the staff development program and discuss the use of scenarios to expand on perceptions of the affordances of the technology and possible implementations within assessment tasks for students.

Background

Mobile learning is defined by various researchers with a focus on the novelty and development of handheld technologies, such as mobile phones, and wireless technologies, such as laptops, allowing easy access to resources. However, Syvänen et al. (2004) warn of the difficulties faced by people "when [they] tend to access information sources and learning objects via different devices from different

locations, there are many usability, compatibility and accessibility related questions still open that hinder mobility and mobile learning" (p. 1). Whilst the focus for the most part in research was on the mobility of the technology, in recent years the focus has moved from this interpretation to recognize it is the mobility of the learner and the learning that is important (Sharples, 2006). O'Malley et al. (2003) have defined mobile learning as taking place when the learner is not at a fixed, predetermined location or when the learner 'takes advantage of the learning opportunities offered by mobile technologies' (p. 6). This shift in focus from the device to the learner being mobile is also noted by Seppälä and Alamäki (2003) in their explanation of mobile learning as an extreme form of flexible learning where the "mobile environment integrates studies that take place on campus, at home or outside universities facilities into one shared, flexible leaning environment" (p.330).

With the explosion of mobile devices in recent years an evaluation by Goh & Kinshuk (2006) conclude that mobile learning can significantly compliment e-learning by creating an additional channel of access for mobile users with mobile devices such as hand phone, PDAs and pocket PCs.
Kynaslahti (2002) makes an effort to identify the elements that need to be considered as impacting on this mobility as:

- convenience

- expediency

- immediacy

We have considered these efforts to define and categorize these new environments and for the purpose of this paper, we define mobile learning or m-learning as:
 Personal access to mobile technologies providing learners with opportunities to be flexible in the way in they collect, store and share information to support their learning.
This paper describes the staff development phase of a larger project originally investigating the potential of three mobile devices, personal digital assistants (PDAs), mobile phones and digital audio players but changed to two devices because of the convergence of technologies which meant only two devices were required, a smartphone and digital audio/video player.

The larger project uses a design based approach to:
1. "Investigate the potential uses or 'affordances' of mobile devices.

2. Engage teachers from a Faculty of Education using an action learning professional development framework to explore and invent pedagogies appropriate to the use of a mobile device in completing a complex task within an authentic learning environment.

3. Implement and evaluate the use of mobile technologies and authentic tasks in learning activities over a period of 3-5 weeks in a range of different subject areas.

4. Describe, categorise and disseminate resultant pedagogies and professional development activities through a dedicated website and a published handbook.

5. Implement the professional development activities for m-learning across other contexts, and disseminate in web-based template form to other universities across Australia and overseas." (http://edserver2.uow.edu.au/~janh/mlearning/Home.html).

The focus of this paper is on the professional development aspect of the larger project, which will support the participants to identify learning activities to support their students' learning using mobile devices.

Methodology
An action learning framework for staff development has been used to provide opportunities to explore and develop new pedagogies to use mobile devices in the different subject areas in an appropriate way. This approach allows the concerns and needs of individuals to be met through inquiry learning rather than a fully pre-planned scope and sequence of activities and is appropriate for professional learning needs in this context (Revans, 1982; Zuber-Skerritt, 1993).

Data was collected during the workshop program through addressing two questions:
1. How do you think these devices could support learning activities in your subjects?

2. How have the workshop activities extended your understanding of the affordances of mobile learning technologies?

Reflections were recorded during meeting sessions and feedback was sought through anonymous evaluations. The cycle of plan, act, observe, reflect was used to continuously review the process of staff development (Zuber-Skerritt, 1993).

Participants

The twelve participants in the staff development process included a range of teacher educators from a Faculty of Education in a regional university. They are lecturers in a range of disciplines within this area including mathematics, science, physical and health education, curriculum, visual arts, educational psychology, literacy, early childhood and educational technology. They bring to the project a diverse and solid understanding of pedagogy with a varied understanding of how new technologies can impact on the learning of their students. Some participants were experienced users of a variety of technologies with a student centred learning focus (for example, Herrington, Oliver and Reeves, 2002; Kerven et al. 2006; Reid et al., 2006). Their enthusiasm and commitment to the project and willingness to change and adapt their understandings to improve student outcomes through the development of new pedagogies is a key driver for this project.

Technology

Selecting mobile technologies for this project was difficult considering the rapid changes in this area and limits imposed by the budget. The initial proposal included three separate devices: a mobile phone; an MP3 player and a personal digital assistant (PDA) but after initial investigations into a range of devices the distinct nature of each became blurred. Issues such as connectivity (bluetooth and/or wireless), computer platform, ease of use, standard features and price were all considered. The final choice was made to provide the best combination therefore reduced to an mp3 player - a 30 GB video iPod, with Extreme Micromemo voice recorder attachment, and a smartphone – the Palm Treo 680, allowing the combination of phone, voice recording and playback, calendar, camera and video recording. Additional covers were purchased for each device to offer protection and to allow for everyday usage situations.

Action learning program

In a recent report on teacher learning with digital technologies the authors point out that there is an assumption that teachers **will** learn with digital technologies but there is little research on **how** they will learn (Fisher, Higgins, & Loveless, 2006). Our staff development program aimed to address this gap through a range of formal and informal activities (Hoban, 2004; Hoban & Herrington, 2005). Lecturers were encouraged to consider the use of the mobile devices as cognitive tools to support learning within an authentic learning environment and this process was modelled within the workshop program (Herrington & Herrington, 2006). By modelling these practices with the digital devices we aimed to support this development.

Most importantly each of the lecturers was provided with one each of the devices to make their own. They were encouraged to insert their personal phone sim card so they could become familiar with the devices in their everyday work. Some were hesitant to do this at first and carried both personal phones and the smartphone with them for the first few weeks. Whilst informal staff development occurred through their own support of each other and the discoveries and sharing involved in their everyday tasks, the action learning meetings were designed to facilitate regular collaboration, reflection and sharing of experiences. Over the university semester a series of meetings were conducted on campus in a non-specialised teaching space. This open classroom allowed for formal presentations by the staff developers and also an area for collaborative tasks between the attendees. Each meeting followed a semi formal structure with flexibility to provide staff considerable opportunity for group discussion and individual problem solving. Initially the meetings focussed on learning to use the technology including: unpacking and preparing the devices for use; initial exploration and sharing discoveries; connection of devices to desktop computers; short introductions and practical tasks using device key features; take home tasks to further explore or extend and understand operational procedures. "At elbow' support was provided as required by the technical staff and 'corridor' meetings also provided day to day support for solving immediate problems with the technology.

Whilst the initial meeting involved familiarisation with the technologies, the following meetings each focussed on opportunities for extending understanding of the affordances of the technologies. Participants indicated a number of challenges they faced with using the devices themselves including:

- Fear of damaging or losing the equipment: "I'm braver now and taking it out when I leave home"

- Concerns about how quickly the battery went flat

- Difficulties with understanding the multi functions of the device

- Loss or duplication of contact files when transferring from personal phone

- Challenges with the use of iTunes (software for managing audio and video files)

- Managing two phones where the participant had decided to keep their personal phone personal

The successes they identified at this early stage were limited:
- Use of ipod as a portable hard drive for one staff member who was moving computers

- Ease of text messaging with the smartphone

- Engaging their own children in support for the devices

In the second meeting, following discussion of the participants experiences with their devices, small groups discussed four researcher developed scenarios (see Table 1 and Table 2) and identified how the devices could support the activities of staff and students. The use of scenarios is commonplace in business and information systems design for the development of insights and understandings and to support the development of a shared vision (Romeo, 2006; Carroll, 2000). The scenarios in this activity were short ones to be used within activities and were designed to assist participants to develop a vision of other uses of the devices. A summary of responses by participants are included following each scenario.

Scenario one: Student on campus
Xin Ro is enrolled in the first year of the primary program. She is involved in a collaborative assessment task about global warming. The team gathers at their first meeting and share the initial resources they have collected. They discuss and draft a plan for their project and identify their roles and responsibilities. They have recorded the discussion to make it easier to write the notes later and use this to draft individual action plans. Clearly the PDAs will be useful for administration tasks for their project, but how can their learning be supported? What kinds of learning activities are likely to be on their project plan? How can mobile devices support these kinds of activities?
- Collect data from around the world by connecting with others to graph trends and note changes.   - Recording voiceovers of extreme weather events   - Giving personal perspectives and understandings about the causes and solutions to the problem   - Interview a range of ages for a range of perspectives
Scenario two: Student off campus
Kenny Cope is a third year student about to go on a practice teaching session. He's prepared five weeks of lesson plans for his Year 4 class after much discussion with the class teacher. He needs to reflect on his teaching and evaluate his lessons. He wants to collect evidence of his work and the work of the students to annotate for his teaching portfolio. What kinds of activities is he likely to engage in during practice teaching? How can the mobile devices support his learning in this context?
- Record Kenny teaching on video and analyse his teaching – wait time, questioning techniques, classroom management, small group strategies   - Use of anecdotal records   - Voice memos to reflect and make changes to his practice   - Collecting work samples using photo, video etc and voice over kids and Kenny's comments as evidence of children learning then informing future teaching   - saving documents as pdf then uploading as needed   - Kenny could text his supervising teacher to organise practical aspects of teaching   - Memos for learning journal   - Audiovisual tool creating a product that shows his school from his perspective

Table 1. Scenarios of student activity and summary of participants' responses

Scenario three: New academic
Dr Way T. Longtime is a new academic in her second year at the university. She must prepare a new first year subject focussed on indigenous education for the next semester. She wants to create an engaging subject that incorporates modelling a variety of teaching strategies. She would like to invite a range of guest speakers from schools and the local communities on various issues but with only a couple of weeks to go she realises this could be difficult. What strategies could she use to add perspectives from the local schools and community to her subject? How could mobile technologies support her or her students to do this?
- Interview the visiting speaker and send it back to the speaker for editing   - Phone calls to key people and recording for podcasting for student access and discussion   - Audio comments   - Set up ipod as database for others to draw on   - Recording interviews for review of issues   - Collecting reflective evidence of her own teaching to plan for future teaching
Scenario four: Experienced academic
Prof Noi Tall is an extremely popular academic and has been on campus for about 10 years. He has been extremely successful with 15 ARC grants and a publication record to die for. This semester is looking grim though. He loves teaching and has three classes this semester, including coordinating a new first year subject with about 100 students. He still has three ARCS to complete this year, a book draft to have ready half way though semester, and is guest editor for a very prestigious journal. Managing his time has always been one of his strengths but he realises that this semester it will be imperative to find some better ways to do this. What kind of activities is he likely to engage in for the new first year class? How can the mobile devices support him to do his job better, both in administration and teaching?
- preparing and carrying the items needed   - retrieving info is easy as you have it there at the time/from last year   - tutorial roles   - easier distribution of info to students

Table 2. Scenarios of teacher activity and summary of participants' responses

Feedback from the participants through evaluation and reflection indicated that the scenarios were a positive experience and that having a point of focus for their discussions was an important component of identifying possible uses in student learning.

The focus of our discussion for this paper is on this particular activity but it is worthwhile noting how the program built on this activity at the next meeting. It created a further challenge by again introducing new aspects of using the devices, in this case using the camera and video tool on the smartphone, and voice recording using the ipod. The participants developed a digital narrative through a storyboard activity and then recorded the elements to publish in a movie using a desktop computer. They completed this task within a one hour timeframe and then presented their movie to the group. This provided an excellent example of how the devices could be used within a learning context in the classroom as the participants quickly became familiar with the combination of movie, photo and sound recording. The next activity used the ipods for interviewing people about their place of work and the resultant recordings were then transferred to the computer and published as podcasts to share with the other participants.

Throughout the meetings the devices were used to support the learning and reflective aspects of the activities. For example, photos were taken during the meetings by all participants engaging in various activities and frequently shared with each other and on the project website. During the reflective stage of each meeting the ipods were used to record the reflections for later analysis by the researchers. The action learning meetings are ongoing throughout the project.

DISCUSSION

The action learning meetings served as a time for team building, for collaboration, for reflection and for sharing ideas. As noted by Collis and Moonen (2002): 'An individual's likelihood of voluntarily making use of a particular type of technology for a learning-related purpose is a function of four 'E's: the environmental context, the individual's perception of educational effectiveness and of ease of use, and the individual's sense of personal engagement with the technology' (p. 219). The meetings enabled and facilitated all of these factors.

The opportunity to discuss challenges and successes at the start of each meeting provided opportunity to address the immediate needs of the participants and to support the development of skills and knowledge of the technology. The collaborative effort involved meant that those who were new to using the technology felt well supported and could turn to each other and to the support staff whenever the need arose. By creating a strong team and acknowledging the strengths of different members the group were able to discuss their challenges in a supportive environment.

Whilst the academics had engaged in discussion about possible uses in the earlier meetings, the scenarios provided the opportunity for in depth discussion in small groups and sharing across the team. The outcomes of the discussions were interesting by virtue of the fact that the participants identified a significant range of activities to engage their students in learning which moved beyond their earlier perceptions of how they the devices could be used in pedagogically sound ways (See Table 1). In particular the scenario about practice teaching addressed a need that many had identified previously but had not found acceptable ways of addressing. Students involved in practice teaching received feedback from the supervising teacher but the academic staff and the other students were not able to observe their teaching practice in meaningful ways to provide discussion and feedback. Students also felt isolated in the classroom situation and the participants felt the opportunity to use the devices to improve this learning experience for the students would be particularly useful, both for communicating with other students and for communicating with the lecturers.

Scenarios 3 and 4 painted a slightly different picture. Whilst similar activities to Scenario 1 and 2 were identified for the relatively new academic, the uses for the experienced academic were limited to very traditional uses of moving files around and sharing information with students. Both activities related to traditional pedagogies involving delivery of information. This may indicate that there was still a lack of familiarity with the devices and recognition of its ability to support academics in such areas as time management, communication and productivity. It was also an indication of lack of ownership of the devices at this early stage. Much of the literature points to the importance of student's gaining 'ownership' of the technology if they are to use them successfully (Corlett, Sharples, Bull, & Chan, 2005; Sharples, 2006). The team felt this was just as important for the academic staff. We wanted them to go beyond being familiar by encouraging them to make them their own. Possibilities included using the planner facility for their diary, taking meeting notes using the hand recognition software or the keyboard; recording research interviews with their ipods, recording activities with the phone camera and the video. This led to planning for the next meeting to include more active involvement in using the devices in practical situations. The storyboarding and creation of the movie and recording of interviews and their conversion to podcasts created a great deal of excitement within the group and extended the possibilities for their use both within and beyond the classroom. Following this experiences involving the productivity tools and managing the related software may further enhance these understandings of the affordances of the devices.

CONCLUSIONS

This paper has provided an overview of an action learning approach to staff development for using mobile devices, including a smartphone and an MP3 player with video capabilities. It is part of a larger project which investigates the use of mobile technologies in higher education to identify innovative pedagogies for teaching and learning. The paper focussed on one aspect of the use of four scenarios in small groups to examine perceptions of affordances of the devices both by students and academic staff. Whilst participants could clearly see the potential for new uses within student learning activities they did not demonstrate an understanding of significant changes to the practices of academics. We concluded that making the devices their own is an important facet of staff development for using mobile technologies, a concept supported in the literature (Kukulska-Hulme, Evans, & Traxler, 2005). This preliminary research provides insight into one aspect of staff development with mobile technologies and indicates that there is significant opportunity for further research into the staff development aspects of

using such technologies if academics are to meet the needs of future students in the higher education sector.

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SELECTION INTERVIEWS USING MOBILE TECHNOLOGY

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ABSTRACT

The use of technology in teaching and learning globally poses a challenge to lecturers at the Tshwane University of Technology. Education and training need to catch up with the growth and wide-spread use of mobile and wireless technologies.

The aim of the study is to explore the potential of mobile devices for selection interviews by, using assessment standards to evaluate the achievement of competencies. The potential of mobile devices is explored in relation to the demonstration of learning outcomes on selection interview competencies as dramatized by students. The interview records are evaluated in terms of standards and time taken to make a decision in appointing a suitable candidate for the job.

The results of the study show slight differences in the performance of students in three cohorts. The performance of all the students in terms of mark allocation was above 60%. The advantage of technology was seen in terms of the standard of documents produced in relation to the results of the selection interview, time spent on inviting candidates to the interview and the reliability of the SMS in that a candidate may get an SMS at any time and anywhere and there is a confirmation that the message has been sent to the candidate.

Key words: mobile learning, selection interview, competencies

INTRODUCTION

The Tshwane University of Technology resulted from the transformation of three institutions of higher learning and is regulated in terms of the Higher Education Act of 1997. The three institutions that merged to form the Tshwane University of Technology were Technikon North West, Technikon Northern Gauteng and Technikon Pretoria. The university has nine learning sites: Arcadia, Arts Campus, Emalahleni, Ga-Rankuwa, Nelspruit, Polokwane, Pretoria, Soshanguve North and Soshanguve South. Total student enrolment is 63 000 (Tshwane University of Technology, 2007-2009).

In 2005 the researcher designed and developed online learning material for Public Human Resource Management II, a course taught in the Department of Public Management, the Faculty of Humanities. The evaluation of this learning material and the adoption of Outcomes-Based Education and Training (OBET) revealed challenges. The **first** challenge related to the failure of the conventional system of education to allow students to demonstrate selection competencies. The **second** challenge was posed by the limited number of computers available to students in computer laboratories and electronic resource centres. Computer infrastructure and connectivity at the Ga-Rankuwa Campus is limited to laboratories and the electronic resource Centres.

The said challenges and the wide-spread use of mobile and wireless technologies among students encouraged the researcher to explore the potential of mobile devices to enhance the teaching and learning of selection interview competencies. The use of these devices was explored with regard to Public Human Resource Management as a component of Public Administration. Selection interview competencies form part of the curriculum for Public Human Resource Management II and the competencies of students were assessed by means of an Electronic Activity (e-tivity) strategy based on assessment standards. A Personal Digital Assistant (PDA) and a mobile phone were used for the e-tivity. A PDA was used to prepare interview questions and record responses of interviewees, while a mobile phone was used to invite candidates to attend a job interview.

Tomei (2003) writes that the use of MS Word and Spread-sheets may enhance students' communication skills, encourage collaborative team work and provide easy to share information for fast decision making based on documents that are clear and of an acceptable standard. The results of this study showed an increase in student performance in all cohorts, but the 2nd and 3rd cohorts that had an opportunity to explore the potential of mobile devices in assessing selection interview competencies had an advantage and were able to make quick decisions on appointing a suitable candidate for the post. These students were also exposed to competencies integrated with technology that can be applied in the world of work.

LITERATURE REVIEW
This section is intended to review literature on the importance of selection interviews as an aspect of learning in Public Personnel Management which is a sub-discipline of Public Administration the academic discipline. Students who desire a career in public management are expected to have the skills and competencies to fill posts in the public service and they also need to be exposed to training that will explore the potential of mobile devices which are growing and spreading throughout the whole world as indicated by Barker (2005) and Leach *et al.* (2005).

Learning selection interview competencies
The field of Public Administration originated as a result of individuals working together to achieve the goals of an organization. The discipline of Public Administration originated from a demand for skilled and competent people trained people to meet the needs of such organizations. As people progress and life becomes more sophisticated, survival needs increase and place pressure on the government of the day to render better and more equitable services to society. Public Administration is responsible for executing government policy and also meeting the demand for trained people with knowledge, insight and skills. These can be used by government departments to enhance service delivery (Du Toit and Van Der Waldt, 1997).

On the one hand, according to Du Toit and Van Der Waltd (1997), the required knowledge, insight and skills to be transmitted to students studying Public Administration are determined by government, employers, researchers in Public Administration, students in Public Administration and society. In this regard the government as the employer and will also determine the type of state. The type of state is determined by political leaders in power and they have to carry out the "twin mandate" (Mafunisa, 2003). Mafunisa (2003) views the "twin mandate" as a political mandate involving roles assigned to political office bearers, Members of Executive Councils [MEC's at Provincial Level and Ministers at National Level] and an Administrative Mandate involving rules, regulations and directives applying to various administrative heads of departments. In order to achieve the goal of a representative workforce, the ruling party must ensure that its programmes are translated into government or executive policy. The office bearers after 1994 were faced by the challenge of addressing the inequalities of the past and a legacy of institutionalized discriminatory human resources practices within the public service. Human resources in the form of political office bearers in the public service had to carry out the mandate of the ruling political party. Carrying out the mandate of a ruling political party requires commitment and loyalty from political office bearers rather than public servants, since the former are accountable to the electorate for the performance of a particular state department (Mafunisa, 2003).

The role of political office bearers in a democratic state like South Africa is to give direction the implementation of policy and expression to common interest. Mafunisa (2003) reiterates Weber's argument in which the honour of a political office bearer is seen to lie in personal and ethical responsibility for his or her actions. The political office bearer should take a stand and be passionate.

On the other hand, the role of a public servant is based on the ability to execute the lawful orders of the superior political authorities. The function of an administrator is more impersonal and passionless. The Public Service Act, 1994 (Proclamation 103 of 1994) defines the role of senior public servants as policy - making, liaising with the political heads of departments, representing the government in forums and implementing public policy. Furthermore, the Act states that the role of the public service is to appoint and fill posts in the public service, with the aim of achieving equality and the democratic values of the Republic of South Africa Constitution Act (Act 108 of 1996).

In the context of this study, the focus will be on filling a post through a selection interview simulation conducted in a classroom supported by mobile technology. The filling of posts in the public service is a function of the management of human resources and is a task performed by staff in personnel administration. To be in line with the ethos of a democratic government, there has recently been emphasis on transforming personnel administration units into human resource units in order to enhance professional support and guidance to management. This has been done in terms of the White Paper on Human Resource Management in the Public Service (1995). The filling of posts in the public service thus begins with the recruitment of suitable candidates which is then followed by the selection interview after the total number of applicants has been reduced by short listing in the government institution concerned.

According to the White Paper on Human Resource Management in the Public Service (1997), in order to respond to the ethos of a democratic government, recommendations were made on re-training and re-orientating employees and managers who to take up new roles within the broad spectrum of democracy in South Africa. In order to achieve the goals of democratic selection interviews, students in Public Administration were encouraged to be well trained in this area (Du Toit and Van Der Waldt, 1997). Appropriate selection interview techniques require skilled and competent employees who are in a position to cope with emerging roles, while catching up with the rapid technological advances of the twenty-first century and the wide-spread emergence of mobile and wireless technologies (Leach, Ahmed, Makalima and Power, 2005). In order to achieve required skills, training institutions and researchers will be required to play a major role.

Training Institutions and Researchers in Public Human Resource Management
Lecturers at institutions of higher learning play a major role in designing and developing learning content in Public Human Resource Management as a sub-field of Public Administration. It is the responsibility of lecturers to attend conferences and read literature to keep abreast with changes in the discipline and conduct research to update literature with the aim of bringing new knowledge into the discipline. In turn students in the sub-field of Public Human Resource Management will also contribute to what needs to be included in the subject, but their role is limited by the fact that they must first, be equipped with the knowledge, insight and competencies required by their professional work. A qualification must meet certain standards in line with higher education imperatives that will allow students to make informed decisions about their qualifications and careers. Academics should gear learning in their institutions towards the implementation of lifelong learning and cope with the rapid advances of the twenty-first century as stated by Leach *et al. (*2005). It is the responsibility of academics in the discipline to also ensure that students adapt to swift technological changes and produce students who are more creative, effective, adaptable and committed to lifelong learning (Van Der Waldt, Van Niekerk, Doyle, Knipe and Du Toit, 2001: and Du Toit and Van Der Waldt, 1997).

Lifelong Learning
The concept of lifelong learning originated from the workers' unions in the United Kingdom. Classes and courses were organized by employers for members of groups like the Mechanics' Institutes, the Miners' Halls and the Workers Education Association. The aim of organizing classes and courses was to improve the education of workers and provide them with access to learning resources and social activities. There was a belief that education could deal away with old fashioned ideas in the work place while developing technical and labour market related skills and knowledge.

It is argued that lifelong learning for the past thirty years has been guided by the increase in the adoption and implementation of technological devices at institutions of higher learning and in the work place. The so called computer driven industrial revolution requires people with skills and competencies to cope with and adapt to swift technological change. It has been suggested that workers need continuous learning to be able to update their occupational skills and knowledge as technology changes (Attwell, 2007).

In order to achieve workers' competencies that will be in line with changing technologies, institutions of higher learning in South Africa will have to play a role in providing lifelong learning to students of the 3G (third generation - which is a method used to categorize facilities available on mobile phones or wireless devices) of teaching and learning . In the UK as in South Africa vocational training was the responsibility of employers and the state played a major role in the provision of education and training. However, in the UK, employees are now responsible for their own employability. In South Africa, the Skills Development Levies Act (Act 9 of 1999) has been passed with the intention of addressing the low level of investment in education and training. Nevertheless it is impossible for government to take charge of education and training and exclude external education providers. Institutions of higher learning are external providers that also have a responsibility with regard to training and educating the nation. The Tshwane University of Technology is one institution that may contribute to lifelong learning programmes. Outcome-Based Education, which recognizes and promotes lifelong learning, has been adopted as the foundation of South African curricula. This system also encourages the integration of technological devices in the education process.

Aligning mobile technology and Outcomes-Based Education and training (OBET)
In order to promote lifelong learning, South Africa introduced Outcomes-Based Education and Training. This system specifies the outcomes expected at the end of a learning programme. It was necessary to replace the conventional system of learning with OBET with the aim of improving education and training and helping students to achieve the skills required at the end of a learning programme (Wessels, 2000).

The integration of OBE and mobile technology was incorporated in a module in Public Human Resource Management II in order to promote lifelong learning and realize the competencies and outcomes expected at the end of selection interview lesson. It was necessary to replace the conventional system of learning with OBE and enhance it with mobile learning to improve education and training so as to achieve the skills expected to be demonstrated by students at the end of a learning programme.

Previously, selection interview competencies had not been transferred to students in a way that would allow them to discharge their professional skills in a practical work environment. Knowledge had only been transferred to students in the form of theory and had not actually engaged them in the activity. " As handheld, wireless computers continue to grow more powerful, less expensive, more mobile and more subject to personalization, the educator's challenge is to consider how they might use these devices to enhance teaching and learning" (Moallen, Chen and Kerman 2005). As a result of this challenge thought was applied to exploring the integration of a personal digital assistant (PDA) to selection interviews. The potential of mobile technology was explored for the first time in 2006, by second year Public Human Resource Management Students in a classroom.

Portable computers
Technological development has made electronic aids more portable. We realize that desktop computer have shrunk in size and weight "to become laptops, and then palmtops, handhelds, and pocketsize personal digital assistants (PDAs)". Handheld devices have become more useful in that they are able to search out essential information on the desktop PC, home office server or internet. Powerful handheld computers or wireless PDAs, may be just right for Web-Based Learning (Loh 2001).

Loh's (2001) findings show that there are benefits to the use of mobile devices. According to Loh (2001), PDAs and smaller versions of computers, unlike laptops have batteries that can run for eight hours or more. PDAs and other mobile computers can be carried anywhere and accessed whenever information is needed. The PalmPilot (now Palm) monopolized and dominated the market for PDAs until April 2000 when Microsoft announced the arrival of the PocketPC that could fit into the pocket of a shirt. The PocketPC functions more like a PC but than a convectional PDA. As the years go by "new devices with better processing power and better software are being released into the market "(Loh 2001).

In the light of the above, the development of ubiquitous computing may come with benefits for those using Information and Communication Technology (ICT) in learning. The first, one is that, under normal circumstances, occupational and vocational training were separated between the workplace and training institutions. Theory was normally provided by accredited providers and practical training by accredited mentors. The use of mobile devices and the rapid spread of connectivity should marry the theoretical aspect of a discipline and the associated practical activities (Attwell, 2007). To link to the above, Public Administration is considered to involve both theory and practice and it has been recommended that students acquire theory and knowledge base in institutions of higher learning and practical experience in the workplace.

The second benefit of ICT is that computer communication for students takes place using the tools of the workplace. In this regard students will benefit since their learning environment will have been developed in conjunction with access and learning skills that will shape their competencies for the world of work. To take the issue of computer communication tools further, they ensure that learning takes place in the context of application. In this regard, the learning material is the occupational tool to carry out knowledge (Attwell, 2007).

The impact of mobile technology on learning
This section briefly describes the impact that mobile technology has had on teaching and learning in developed countries and considers the possibilities for exploring the use of mobile phones as they are adopted at a growing rate world wide. Mobile Computers were introduced in 1996 and are growing fast in

the market. The fast- maturing market for Mobile Computers and the acceptance of online learning and Web-based instruction has led to investigations into the use of mobile computers in Web-based environments where they can empower students engaged in lifelong learning, such as those at my university of technology(Loh 2001).

The terms, mobile technology or portable devices or hand held devices refer to Pocket PCs, handheld computers, portable note books, palm tops and Personal Digital Assistants (PDAs) and Universal Serial Bus (USB) drives (Loh 2001:5).   Handheld computer devices like PDAs were originally designed for personal information management, but were later converted to use mobile phone technology in 3G phones or 'smartphones'. These portable devices may be used to transfer information from one device to another with the aid of Bluetooth or Infrared.

A Personal Learning Environment was agreed to be a new approach to using technologies for learning that recognize that learning is continuous and seeks tools for support. Lifelong learning encourages students to be responsible for their own learning environment and thus supports the concept of a Personal Learning environment (PLE), emphasized by Attwell (2007). A PLE also recognizes the role of the individual in ongoing learning, which is not provided by a single learning provider. Linked to this scenario will be the development of PLEs through changing technologies, such as for instance using a PDA to access the internet to enhance learning. A PDA is regarded by Attwell (2007) as an example of ubiquitous computing which is not yet fully developed but may be piloted for activities like the one in this study. A PDA can also be regarded as a portable computer, as is indicated in the paragraphs below.

The Minges report (2004) quoted by Leach (2005) indicated that the use of mobile devices in the past five years in Africa had increased at an annual rate of 65%. To add on the statement on the increase in the usage of mobile phones, in South Africa the mobile subscriber per 100 populations was at 35% in 2004. Barker (2005) reiterates Jensen (2002) by indicating that 1 in 35 people in South Africa have a mobile phone. This number might have increased subsequently. A table on this growth drawn by Barker (2005) from the World Development Indicators Data Base, 2004, further reiterates the views expressed in the Minges Report (2004) by also emphasizing the rapid growth of cell phones in Africa and, more specifically, to South Africa. Mobile communication is considered to be particularly successful in South Africa.   In Africa, the International Telecommunication Union by indicates an increase of 1000% in cellular phones subscriptions between 1998 and 2003.

According to Barker (2005) cellular networks serve about 24 million customers in 48 countries, South Africa included. All of this indicates that an appropriate device for learners in South Africa may be a cell phone. Research has also shown that educational materials designed for mobile learning have been evaluated positively by learners and there is evidence that students are able to learn via the medium. The development is an indication that ICT will address the obstacles of time and distance for people throughout South Africa (UNESCO 2003 in Leach *et al.* 2005). Mobile learning is a reality and a success in South Africa, since it has grown in form, structure and importance to become an environment of choice. Despite the massive use of cell phones in general, the use of mobile devices in South Africa for teaching and learning is not yet wide-spread (Leach 2001 and Barker 2005).

Barker (2005) refers to the European-based M- learning project that mainly showed that poor literacy, reinstate to participation to conventional learning and the gulf between ICT "haves" and "have nots" brought about to a lack of access to computers may be resolved by using handheld devices. In the view of Barker (2005) poor literacy and the gap between "haves" and "have nots" may also be found in developing countries like South Africa. The issue of learning by choice through mobile technology is also raised.

Research has also shown that the use of PDAs and mobile phones may an effective tool for communicating in a foreign language like English, which is used as a language for learning in most South African Universities. The use of mobile devices in the field of Public Administration still needs to be explored based on what will work and what will not work, and it is hoped that this paper will give new impetus to research into the potential of these devices, which are able to search for wireless connectivity and allow internet access within the wireless cloud.

AIM OF THE STUDY

The aim of this study is to explore the potential of mobile devices to enhance select ion interview skills by way of dramatizing such interviews in a classroom. This should allow students to demonstrate selection interview competencies that later can be applied in the world of work.

METHOD

In enhancing competencies of students by using the support of mobile technology, Tomei (2003) emphasizes, the widely accepted ABCD format and Manger's behavioural objective models for writing objectives that are specific, observable, measurable and unambiguous (Tomei, 2003). The ABCD format and the Manger's behavioural learning objectives are considered to be the widely accepted models for writing lesson objectives.

Considerable thought was applied to achieving the learning outcomes of a selection interview, using the intervention of mobile technology from 2005 - 2007. Dates were arranged for activities to be conducted in the classroom and students had to write a report and conduct a class presentation. Students were given the necessary support and motivation and rehearsals were done before the actual activity began. A selection interview activity recorded manually on the selection score sheet in 2005 was compared with the electronic score sheet used in 2006 and 2007. The competencies of students were aligned with learning outcomes expected to be demonstrated by students at the end of this learning module.

Mobile devices explored by this study were a Personal Digital Assistant (PDA) and a Mobile Phone. On the one hand, students prepared interview questions which were later transferred to PDAs. The interviewers recorded responses on MS Word and on a score sheet in MS Excel, both of which were premised on enhancing the learning outcomes of a selection interview, and achieving clear records that were easy to read and duplicate in order to make possible a swift decision when appointing a suitable candidate for a post. On the other hand, a mobile phone was used to invite short-listed candidates to an interview. Students were assessed on their ability to invite a candidate to an interview and arrange a date, time and venue for the interview.

PARTICIPANTS

According to Tomei (2003), the letter (A) for audience in the ABCD format mentioned above, refers to the students for whom the instructor will be designing learning material. The material is based on lesson goals and targets illustrated in step1, in table 1 below. The participants in the study were three cohorts of second year Public Human Resource Management II students registered for a National Diploma in Public Management. The first cohort of 207 students participated in 2005, the second cohort of 140 students in 2006 and the third cohort of 144 students in 2007.

PROCEDURE

The (B) in the ABCD format represents the behaviour component of learning outcomes and is a synonym for learning outcomes that are measurable, in terms of content and action (Tomei: 2003). Learning outcomes for the lesson activity are illustrated in step 2, see table 1 below. The behaviour component for learning outcomes is illustrated in a **table 1** below, in order to clarify the transfer of information to a PDA.

TABLE 1: BEHAVIOUR COMPONENETS FOR LEARNING OUTCOMES

Step 1: Lesson Goals and Targets	*Step 2: Learning Outcomes:*	*Step 3: Material and resources*
Theme: To guide students and human resource practitioners in the selection and appointment of staff **Grade:** NQF Level 5 **Time:** 90 minutes	To show the ability to - receive and grade applications; - plan and conduct an interview and formulate appropriate questions for the interview; - shortlist and invite candidates to an interview; - justify the selection decision and give feedback to unsuccessful applicants.	- WebCT /Web site - Literature resources - Video cassettes - Journals
Step 8: Student learning evaluation	*Mobile Technology (PDA and a cell phone)*	*Step 4: Initiating activities*
- Assessment standards were used to evaluate reports posted to the facilitator on WebCT - Reports were marked electronically and posted back to students after they were graded		- A class presentation based on the selection and appointment of staff - WebCT Notes
Step 7: Technology infusion	*Step 6: Concluding activities*	*Step 5: Developmental activities*
- Computer–Assisted instruction – Questions formulated were transferred from a laptop to a PDA - Simulation Instructional Media – Students were encouraged to watch a DVD or Cassette or online Video to guide them on how to conduct an interview - Word processing on a PDA – Interviewees' responses were recorded - Spreadsheet on a PDA – It was used to record response on a score sheet	The ability to - report and defend the selection method used in conducting an interview; - justify the selection decision and state why unsuccessful applicants were not considered	- Practice how to write an application letter and compile a CV - Practice how to fill in an application form - Have knowledge of the importance of adhering to a closing date, certifying copies and attaching requested supporting documents

(Tomei 2003)
Key NQF = National Qualification Framework
CV = Curriculum Vitae

A team of students engaged in a project had roles to play to achieve the outcomes illustrated in **table 1** above at the end of a module in selection interviews. Members of a team are normally governed by rules based on timeframes and the procedure followed to execute tasks (Hung & Wong, 2000).

This was intended to enhance selection interview skills by using a handheld device similar to communication tools used in the workplace. On the one hand, exploring the potential of PDAs to enhance selection interview process will resemble an activity relating to a personnel function in a work

place. On the other hand, the learning process will be shaped by carrying out work in a learning environment (Attwell, 2007).

The (C) in the ABCD format model represents the condition and the (D) represents the degree (Tomei: 2003). WebCT, e-tivities were created and a team of students was expected to formulate interview questions to be transferred to a PDA and respond using the short message service (SMS) on mobile phones. The team had instructions and guidelines to follow in order to achieve the competencies required for conducting a job interview compiled on a PDA. The e-tivities had clear instructions and mark allocations, since TUT still uses the point system, assessment criteria and presentations as ways of reporting to peers the investigations conducted by teams. In order to achieve the outcomes of the activity, team members had roles to play based on the conditions described in the next paragraph.

The conditions were based on achieving the outcome stated in step 2 in table 1, and were based on clear and straight-forward instructions. Team members had requirements to fulfill. Team H members were expected to nominate the interview panel; view a DVD or video cassette or search for any relevant information in books or journals or on the web on how to conduct a selection interview, represented by step 3 on material resources in table. Steps 4, 5, 6, and 7 also supported the instruction by providing activities that led to the achievement of outcomes and the use of technology to facilitate gaining learning selection interview competencies, see table 1 above.

In the study degree for student learning evaluation, was based on assessment standards for outcomes, represented by step 8 in table 1. Students were required to demonstrate that they could investigate different types of interviews and select the relevant type of interview for the post; were able to prepare selection interview questions to be later transferred to a PDA, were able to conduct an interview while recording response data on a PDA and were able to initiate and close a selection interview. Students were encouraged to nominate a spokesperson to present their work to all other teams in the classroom.

EFFECTS OF THE USE OF MOBILE DEVICES

This section focuses on the findings of this study in exploring the use of mobile devices in teaching and learning in the classroom. On the one hand, research showed that development and support for the use of PDAs in learning may come up with a radical shift in the use of education technology and the organization and ethos of education. Students may be encouraged to be more responsible for their own learning, which may result in them being more independent. Students may also an opportunity to be provided with skills and competencies that will allow a balance between institutional learning and learning in the wider world, according to Attwell (2007). "Change is difficult but it is probable that the rapid development and implementation of new technologies and social change make change in our education provision inevitable" (Attwell, 2007).

To link the above to selection interview competencies and other research results, a report by Barker (2005) reveals that handheld technology has beneficial impact on students' learning environment in the classroom, since there is engagement, collaboration and independence shown by students when they are thoughtfully integrated in a classroom. Barker (2005) reiterates Becta (2004) by emphasizing a concern about the availability of information regarding the potential of mobile devices to enhance learning for both students and lecturers and the time required to practice their use.

On the other hand, selection interview activity results, revealed the ability of a team of students to demonstrate competencies through simulations and self discovery in the classroom. Students were able to debate among themselves and choose a suitable type of interview and defend it and select and shortlist a suitable candidate for a post in all three cohorts.

In the first cohort, and this was not the case for the second and third cohorts, students communicated verbally among themselves in selecting suitable candidates for a post and interview questions were hand-written on paper. In the case of the second and third cohorts, students responded to applicants by short message system (SMS). The SMS was considered to be an advantage by students in that it was cheaper, faster, and clearer to deliver the invitation to the respondent in this way. The selection panel was in a position to know instantly if the message had been delivered or not; there was no need for any individual to be at a particular place and the candidate was in a position to get the information anywhere and at any time. The invitation message was also sent to the lecturer as evidence of the work done.

The students managed to prepare interview questions on MS Word, save them on a USB flash disk, transfer them to a Lap Top and later to a PDA (with the support of the mobile learning consultant and lecturer).

Students in all cohorts were able to dramatize a Job interview in a classroom and a panel of 3 students conducted an interview from questions prepared on paper for the first cohort and on a PDA for the second and third cohorts. Panel members for the second and third cohorts wrote comments and responses on MS Word File and the MS Excel Spread Sheet to evaluate responses at the end of an interview, while the first cohort used paper.

Tomei (2003) wrote on Word Processing as a commonly used computer application in the classroom. It is argued that word processing may enhance the student's self perception of being a real writer. It produces a more professional image, and may bring about acceptable writing for both communication and publishing. It will normally be easier for students to share information about their work with others and encourage collaborative writing and student discovery.

Although students in all cohorts worked as a team, the second and third cohorts had an opportunity to explore the potential of mobile technology and shared ideas and collaborate and form relationships using mobile technology to access MS Word and MS Excel. Their decision making was based on a new environment, in which they applied the MS Excel Spread Sheet and MS Word File Document on a PDA to making a decision on a suitable candidate for a job. These skills can all be later, applied in real world situations.

At the end of the interviews, suitable candidates for the post were selected for appointment in all three cases, even though the decisions of the last two cohorts were made in a different environment. In a nutshell, for outcomes were achieved through demonstration and discovery; the performance of team members in all cohorts was satisfactory and the exercise promoted creative thinking for both the learners and the lecturer as both had the opportunity to explore the potential of a PDA and a cell phone for learning activities.

The team members who were engaged in the activity were happy about their performance and reports to their peers, but their concern was that the two hour training session offered to the last two cohorts was not long enough. Team members and the rest of the group were fascinated by the use of the PDA and they indicated that they were happy about the activity which had given them an experience of a real life situation that they would face as future personnel administrators and job seekers.

CONCLUSION

In conclusion, mobile technology is new in the assessment of learning selection interview competencies and skills that may empower students to have insight and knowledge, relevant to the world of work. Students using it are able to have their own space and time under their control. Separate learning contexts may be brought together, that is the knowledge provided by institutions of higher learning and the employer may be integrated. Students may learn to be responsible in developing competencies and skills. A gap between education institutions and the world of work may be closed by the use of devices that may be used in both environments. Students may develop judgment and skills relevant to adapting to the swift changes in technology in a rapid changing society (Attwell 2007).

In the case of this study, the researcher evaluated the progress of students in achieving outcomes using assessment standards that measured the growth and decision-making skills of students. Instead of pencil and paper, word processing and spread sheets were used. Assessment standards were based on the ability to make a class presentation, make a decision on the relevant type of interview, formulate interview questions, conduct an interview and record responses on a PDA by the first and second cohorts and the ability to invite candidates to an interview and provide feedback to unsuccessful candidates using an SMS (second and third cohorts only).

Based on the student learning evaluation records, it can be concluded that mobile devices have the potential to enhance selection interview competencies. A mobile phone and a PDA were considered to have advantages over hand written paper records. A mobile phone is considered to be a fast, clear and

reliable means of inviting a candidate to an interview, since there is immediate feedback on whether the candidate has received the message or not.

A PDA was also considered to be helpful, in allowing students to make a decision on appointing a suitable candidate for the post, based on clear text and, easy to share information. Students who used mobile technologies had more opportunities to discover the uses of these novel devices.

Students in both cohorts who used a PDA were asked to comment on the use of mobile devices and they suggested that they needed more time to practice writing on MS Word and MS Excel on a PDA. They felt that the two hour preparatory training was not enough. There was not much difference in the performance of students in all three cohorts, but the use of mobile devices had advantages on enhancing selection interview competencies in terms of the standard of documents produced; time spent on making decisions; information sharing and collaborative work.

It is recommended that lecturers in Public Administration should consider the integration of mobile devices in teaching and learning, especially for activities that can bridge the gap between the theory and practice of Public Human Resource Activities. Mobile Devices have an advantage in that they can be taken to the students to demonstrate an activity in the classroom.

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MOBILE TECHNOLOGY AS A MEDIATING TOOL FOR LEARNING IN THE CONVERGENCES FROM TECHNOLOGY, COLLABORATION AND CURRICULUM PERSPECTIVES

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ABSTRACT
This paper identifies a number of convergent developments made possible by the emergence of mobile communication devices: (a) from a technology perspective: the convergence of mobile and Internet technologies; (b) from a collaboration perspective: the convergence of distance collaborative learning with face-to-face collaborative learning; and (c) from a curriculum perspective: the convergence of formal with informal learning. This paper describes these developments and identifies the most likely synergies that can be gained for learning. We stipulate that for mobile learning technologies to realize their full potential, they must play the role of mediating tools, mediating between the individual learner and his or her social and physical environment. Seeing mobile devices as mediating learning tools implies that they need to support not only communication and access to information on the Internet, but also function as scaffolding and experience capturing devices.

This paper also briefly outlines a research project that integrates the three perspectives specifically to learning: (a) from technology perspective – Mobile Learning; (b) from collaboration perspective – Collaborative Learning; and (c) from curriculum perspective – Informal Learning. Mobile, collaborative and informal learning with a Learning-By-Design concept form the basis of this research study.

INTRODUCTION
Whenever a new technology is introduced to education, there is going to be a risk that without proper considerations for learning, the technology may end up impeding rather than enhancing learning. This is true for the introduction of mobile technologies as learning support devices (m-learning). This has been the case for all learning technologies so far: first generations of computer-based training, multimedia-based education, and web-based learning all have initially (and for quite some time) been less effective than their respective predecessor, starting with print materials (Alessi & Trollip 2001). To ensure that the quality of learning will be improved, developers and designers will always need to keep in mind the key ingredients of a good learning environment: well-designed content, ample opportunity for scaffolded problem solving, frequent and in-depth collaboration with other learners, and opportunities for gaining feedback and reflection.

In this paper, we suggest that the main value mobile technologies add to learning is not that a qualitatively new set of tools made available to learners, but rather these mobile (communication) devices can bring together what belongs together in a rich learning environment: *acting* in the physical world (classrooms, outdoors), *accessing* symbolic resources (text, sound, video on the Internet), and *interacting* with others. We see this overall convergence taking place along three dimensions: technology, collaboration, and curriculum.

Technology Perspectives: Convergence of mobile and Internet broadband
Both mobile and Internet technologies aim to provide services to customers at fast speed and high mobility, and these two technologies may converge using the mobile communication device. For *mobile* technologies, since the introduction of the third generation (3G) mobile phones, the mobile communication device has become a convergent device of phones, cameras, music, video displays and even multimedia wireless computers (Sharples et. al. 2006).

Internet broadband technologies moved to the wireless realm after the invention of smart antenna using orthogonal frequency division multiplexing (OFDM) with radio spectrum from 10 to 66 GHz (radio waves at these frequencies can penetrate into building and it can bend and reflect around obstacles). Instead of using fixed broadband technology, users were beginning to access Internet services using wireless broadband with fast speed and high mobility (Withers 2005). Subsequently, the IEEE officially approved the IEEE802.16e (mobile version of Worldwide Interoperability for Microwave Access WiMAX) as a

standard in Wireless Metropolitan Area Networks (WMAN) which contributed to further advancement of the wireless broadband technology.

These two technologies will most likely be converged to become a "Mobile Wireless Broadband" technology. Telecommunication Companies (Telco) and Cellular Companies (Cellco) may converge for they both aim to provide fast Internet services and high mobility to the customers using wireless broadband and/or fourth generation (4G) roaming. Figure 1 shows how the 'Mobile network' and 'Internet Broadband network' are converging to the same market segment to provide mobile wireless broadband to customers to access high speed broadband internet with good mobility. With the convergence of mobile and Internet broadband technologies, mobile communication devices can act as a mediating tool for learners to enhance their ability to *act* in the physical world, *access* symbolic resources and *interact* with others.
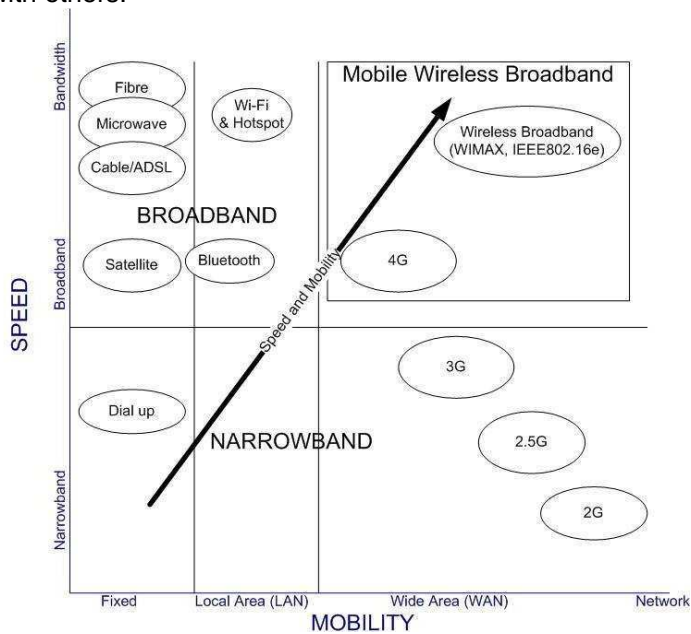
Figure 1.   Convergence of Mobile Wireless Broadband
[Source: Adapted from Withers, J. (July 2005) Access Landscape of mobilizing Broadband]
Collaboration Perspective: convergence of distance collaborative learning with face-to-face collaborative learning
While Personal Computers (PCs) as 'clients' have empowered students and teachers to communicate and collaborate with each other by accessing server and web services, it has proven harder than expected to create collaboration platforms that are close to the richness and ease of 'natural' face-to-face (ftf) communication. Dillenbourg (1999) and Station et al. (2001) both note that social interaction among peers and learners is the basic element to achieving learning. Collaborative face-to-face social interaction has benefits that can lead students to achieve significant academic performance and hence motivate them in learning (Johnson & Johnson 1999). However, PC has been designed for personal use with the expectation that learners sit behind a computer screen (Zurita et. al. 2004). Even in the form of a laptop, the physical design of PC is still somewhat difficult to integrate into (ftf) classroom, and children are not known to carry around their laptops when going to malls or other physical meeting places.

Zurita and Nussbasum (2004) claim that the weaknesses associated with PC-based collaboration can be addressed through *Mobile Computer Supported Collaborative Learning (mCSCL)*. Mobility allows learners to have the physical control and interactivity in their collaborative work since they can carry the mobile device while they establish a face-to-face interaction. Using mobile technology can help to gain back the benefits of face-to-face collaboration. Learners can use mobile devices to enhance their face-to-face collaboration with peers and to interact freely in the context.

mCSCL is not trying to compete with PC-based collaboration that learners can enjoy learning being at a distant location. The most important argument of the convergence is that learners can regain face-to-face collaboration with the computer support using mobile devices. With the help of mobile devices,

mCSCL can give learners the opportunities to: (1) interact with the environment, (2) be co-located to collaborate with peers, (3) capture their experiences, and (4) access additional Internet information. Further advancement of mobile technologies may open up the exciting possibilities in the future to mediate interactions with peers at a distant location whilst allowing learners to enjoy face-to-face collaborative learning. When this happens, mobile devices will be able to support the convergence of distance collaborative learning with ftf collaborative learning. Then, mobile learning support devices can fulfill entirely the purposes of *acting* in the physical world, *accessing* symbolic resources and *interacting* with others at both co-located and distant location.

Curriculum Perspective: convergence of formal and informal learning
While teachers like to be engaged in informal learning using mobile device as a mediating tool for learning, they find it hard to adopt it in curriculum-oriented formal learning environment. Vavoula (2004) and Diamond (1999) view informal learning as non-formal learning with little relations to curriculum. Scanlon et.al. (2005) also highlight the contrast between intentional formal learning ("goals and process learning explicitly defined by teacher") and unintentional informal learning ("goals of learning are not specified in advance but they can develop as a learning occasion arises"). As shown in Figure 2, there are many informal types of learning such as mobile learning, museum learning, game learning or even podcast and video-cast learning but most of them are non-curriculum-oriented. In order to achieve more organized type of learning instead of a casual or 'disorgainsed' one (Sefton-Green 2004), many researchers attempt to establish activities of informal learning based in the curriculum.

In other words, *curriculum-oriented formal learning* (e.g. school learning) and *non-curriculum oriented informal learning* (e.g. learning at museum, gallery or zoo) are converging to *curriculum-oriented informal learning* (goals of learning explicitly defined by the learner but linked with the curriculum). In Figure 2, the two arrows showing how curriculum-oriented formal learning and non-curriculum-oriented informal learning converge to curriculum-oriented informal type of learning. Both teachers and students will be delighted to be engaged in an informal learning with curriculum-oriented such as learning at museum, but to have the object of learning linked to the curriculum. This type of learning will be more organised and measurable (Sefton-Green 2004) so that teachers would find it easier to adopt in formal learning setting for it is linked to curriculum and students are willing to participate for it creates more fun to be working in an informal learning environment setting.(e.g. at museum or outdoor). Using mobile devices as a mediating tool, curriculum-oriented informal learning (e.g. mobile learning with the context setting that is linked to the curriculum) will be the ultimate convergence of formal and informal learning. However, before introducing the mobile devices as a learning support tool for learners, we need to ensure the key ingredients of a good learning environment in curriculum perspective: well-designed content that linked to curriculum, frequent and in-depth collaboration with peers, and scaffolding.
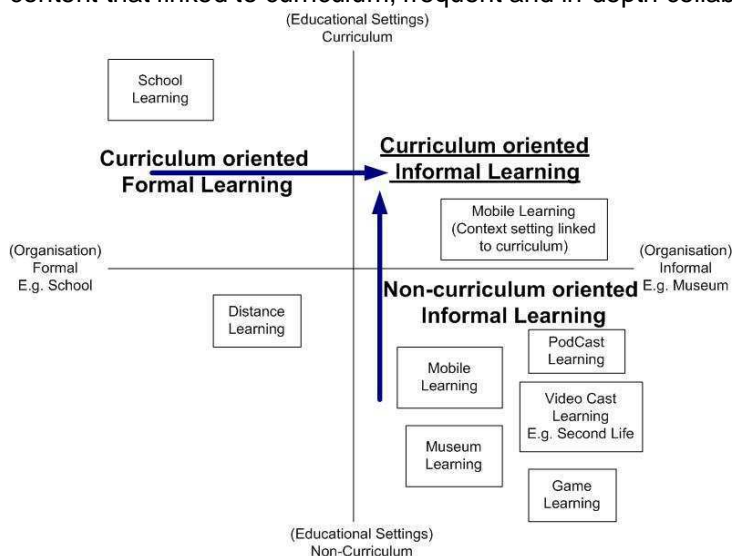
Figure 2.   Education Setting (Curriculum/Non-curriculum) against Organisation (Formal/Informal Learning)
Convergences from Technology, Collaboration and Curriculum Perspectives
The convergences in technology, collaboration, and curriculum perspectives are summarized as in Figure 3. It further shows that mobile technology (e.g. mobile devices) can act as a mediating tool for learning.

		Convergence	
Technology	Mobile →	Mobile Wireless Broadband	← Interent Broadband
Collaboration	Face-to-face collaborative learning →	Face-to-face Collaborative learning (Using Mobile devices)	← Distance Collaborative learning
Curriculum	Curriculum-oriented Formal Learning →	Curriculum-oriented Informal Learning (Supplemented by mobile devices)	← Non-Curriculum-oriented Informal Learning

Figure 3. Convergences from Technology, Collaboration and Curriculum perspectives Mobile Collaborative Informal Learning

The emergence of mobile communication devices generated a number of convergences from technology, collaboration and curriculum perspectives. More specifically, we will focus on the integration of these perspectives in technology, collaboration and curriculum at the point of mobile, collaborative and informal learning. While there are many research projects in mobile learning and/or with collaborative learning, very few of them integrate these three perspectives of mobile learning, collaborative learning and informal learning together. Many research projects in the area tend to focus on how to establish mobile activities using the mobile devices, but are often weak in providing a rich learning environment.

Conclusion

Without a good learning environment, mobile devices will be just another set of tools for learners and cannot guarantee quality learning. Whether mobile devices can successfully act as a mediating tool for learners depends on whether the mobile learning activity design is set in a rich learning environment that can enhance learners to *act* in the physical world (classroom or outdoor), *access* symbolic resources (text, audio, video on the Internet) and *interact* with others (peers or experts) effectively. The convergences in *Technology* (mobile and internet broadband), *Collaboration* (distance with ftf) and *Curriculum* (formal with informal) also play a vital role to this success to make mobile devices as a mediating tool for learning to our community.

Further Work

This research project "Mobile Learning Design at a Technology Museum" is funded by the Australian Research Council (ARC) Linkage Grant and conducted by The University of Sydney in conjunction with the Industry partner of the Powerhouse Museum. The *theoretical framework* used in this research study employs the *Learning–By-Design* concept (Kolodner et. al. 2003). The research project allows students to engage in mobile, collaborative, informal learning through participating in a design activity on a specific topic (Learning-by-Design concept). Instead of solely setting up mobile activity for learners, learners will have the opportunities to participate in designing the exhibitions with the help of a 'design environment tool' using online collaboration and/or mobile device in an informal learning context.

The mobile learning design described is based on the key ingredients of a good learning environment: well-designed contents linked to the school curriculum and museum exhibits; scaffolded problem-solving for a 'real-world' case; collaboration with peers and professionals; and formative feedback of their exhibition design in various stages. This research study will focus on the effect of student learning after using mobile technologies (in particular the Tablet PC) in an Informal Learning setting at a Museum context. This study will look into the impact of the mobile, collaborative, informal learning environment on student learning and further explore whether mobile device can act as a mediating tool for learning. It will also be studied how to relate learning technologies and learning activities, in particular those linked to school curriculum and to those which are only available in museum spaces (exhibits). The involved students will be the junior level high school students and the project is currently in progress.

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MATHEMATICS ON THE MOVE: SUPPORTING MATHEMATICS LEARNERS THROUGH MOBILE TECHNOLOGY IN SOUTH AFRICA

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ABSTRACT
This paper discusses research in progress on the challenges and opportunities for technology enhanced learning; specifically mobile learning in a South African context, where PC penetration is limited but where about three million teenagers have Java enabled cell phones. It provides a brief discussion of the South African landscape with specific reference to mathematics and science education. The research approach is action research within the framework of activity theory. The paper concludes with the description of a mobile learning solution for mathematics which attempts to combine edutainment with tutoring via narrowcasting, within the constraints posed by the educational and technical environment in South Africa.

Author Keywords
Mobile learning, Mathematics learning, technology enhanced learning, learner support, edutainment

INTRODUCTION
M-learning (or mobile learning) is seen as an extension of e-learning where the focus is on the use of mobile devices such as cell phones, PDAs, and iPODS (Brown, 2005). Laouris and Laouri (2006) describe the move from e-learning to m-learning as a revolution since it implies not only a change in terminology but a change of mindset when designing and planning learning environments and goals. Sharma and Kitchens (2004) assign this unavoidable change in paradigm to the unique facilities provided by mobile technology such as the provision of communication facilities at any time or location and the provision of learning content dynamically dependent on the learner's location, context and device (Sharma and Kitchen, 2004). This necessarily implies a change in classroom culture.

It is also clear that the exposure to a greater variety of media is causing a different kind of learner who gathers and process information differently. Mellow (2005) describes this new generation of learners as the media generation whereas Prensky (2001) uses the metaphor of "digital natives" to get a better understanding of the kind of learner educators are dealing with. Mobile technology is part of the "digital natives'" lives and it seems logical that educators should explore the possibilities of applying these technologies in educational settings (Mellow, 2005).
The situation in developing countries are of course somewhat different and quite a few researchers have asked probing questions on the role of technology enhanced learning (if any) in such settings (Brown, 2005; Masters, 2005, Laouris and Laouri, 2006).

THE SOUTH AFRICAN EDUCATIONAL LANDSCAPE
The South African educational situation may provide interesting lessons to learn for the implementation of mobile learning in developing countries. Quite a few educational challenges need to be faced in SA: 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.

ADVENT OF MOBILE TECHNOLOGY IN SOUTH AFRICA
However, this does not indicate that South Africa is an "unconnected" society. Because of the inaccessibility of wired networks in SA, the society has moved to wireless networks. Mobile phones are used by a large percentage of South Africans irrespective of race, age, income group or gender. The International Telecommunication Union (ITU) figures show that in 2004 South Africa's mobile phone density was 36% compared to the 6% of Africa (ITU, 2004). One can mention the MXIT phenomenon by way of illustration: already close to 3 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.

Several m-learning projects already exist in South Africa. Masters (2005) describes work done at the Faculty of Health Sciences at UCT on the use of early generation mobile phones to supplement administrative procedures. Brown (2005) reports on a model for m-learning in Africa which is based on the experiences gained through research done at the Faculty of Education, University of Pretoria. The model is evolving and focused initially on administrative support only for students. It is envisaged that it will include academic support as well in 2007 through the provision of e-learning course material, study guides, tutorial letters, multiple choice assessment, motivational messages, tutor services and appropriate feedback. However, all of these tend to be small-scale projects with a focus on reaching hundreds rather than thousands of learners.

THE SOUTH AFRICAN SCIENCE AND MATHEMATICS EDUCATION PROBLEM
The Centre for Development and Enterprise (CDE) released a report in November 2004 on the state of mathematics and science education in SA. The report covers three years of research, analysis and discussions with over 1000 experts. The main conclusion is that despite efforts from the government as well as private sector, the throughput of students with maths and science on higher grade level is far too low to provide the country with the necessary skilled workers to build its economy (Anonymous, 2004). The research revealed that only 4637 African learners matriculated with higher grade mathematics in 2002. The shortage of qualified teachers contributes to this problem. Groenewald (2002) estimated the shortage of mathematics teachers and science teachers to amount to 4000 and 12 000 respectively in the year 2002. One of the recommendations of the CDE is that higher performing schools should be supported and ways in which they could assist other schools should be investigated. They also urge private sector to come up with focused initiatives.

TECHNOLOGY ENHANCED MATHEMATICS LEARNING IN SOUTH AFRICA
The shortage of qualified maths and science teachers led to some initiatives where one or more teacher is used to reach a large group of learners through ICT. One such an example is tutoring through the medium of television. Mindset Learn is such an educational programme offered via satellite television with additional multimedia support. The programme is offered five days a week, nine hours a day and focuses on the teaching of English, Mathematics and Science on secondary school level (Mmekoa, 2005).

Technology enhanced mathematics teaching and learning is implemented in both primary and secondary schools (of which most are private schools) in the form of drill-and practice software dynamic representation software (e.g. Geometer's Sketchpad), tools to do the drudgework (e.g. scientific calculators). On postgraduate level, computer algebra systems such as Matlab are in use in many South African universities either in the teaching of students or the teaching of teachers. The Department of Mathematics at the University of Pretoria is also busy with a project teaching calculus online (Engelbrecht and Harding, 2005).

Recently some efforts were announced to teach mathematics via MXIT (and other Jabber-based chat platforms). This basically presents a text-based environment to interact with learners on a one to one basis. Although research on this is still ongoing, this approach does appear to hold much promise, provided that the logistics required for such a real time effort could be resolved in a sustainable manner. The time seems ready to test the ground for the possibilities of mobile mathematics learning in South Africa.

PROPOSED RESEARCH PROJECT AND CASE STUDY

Case study
IT School Innovation (ITSI) is a Southern African high school computer education company established in 2000. Recently the company decided to widen their focus to "Technology Enhanced Learning" and then specifically via mobile platforms. The "M☺BI Maths" project is one of these added services. The Department of Informatics of the University of Pretoria considers this an interesting project as a case study with many research possibilities.

The basic research question which will be addressed is as follows: what contribution can a mobile tool such as M☺BI Maths make to enhance mathematics learning on a secondary school level in a South African setting?

Research method
Action research seems to be the ideal strategy to approach this project. McKay and Marshall (2001) describe action research (AR) as a "juxtaposition of action and research". The outcome of action research is therefore two-fold: improved or altered action/practice and new knowledge. Oates (2006) sees AR as an iterative cycle of plan-act-reflect with an emphasis on change and collaboration with practitioners. Also, Oates (2006) gives the five stages of the plan-act-reflect cycle as diagnosis, planning, intervention, evaluation and reflection. What makes this different from ordinary problem solving or consultancy is that the researcher work from within a conceptual framework which both informs and is being changed by each cycle of plan-act-reflect (McKay and Marshall, 2001). Also, data is collected throughout the cycles (through questionnaires, interviews, observations etc) to enable evaluation and reflection.

This project has now passed the planning phase of the AR cycle and has reached the intervention stage. At this stage most of the challenges and obstacles which have been identified in the planning stage on both educational and technological levels, have been addressed. These are discussed briefly in the paragraphs that follow.

We intend to use activity theory as the underlying theory informing the next phases. Similar to Waycott, Jones and Scanlon (2005) we feel that the particular strength of activity theory in this context is its assumption that tool mediation is central to all human activities. Also, by referring to the work of Sharples, Taylor and Vavoula (2005), and using activity theory to analyse learning as a cultural-historical system, two layers of tool-mediated activity are exposed: the semiotic layer which in our case will include the mathematical "language" on the one hand and on the other the technological layer which represents learning as an engagement with technology. Also, one of the main premises of activity theory is that activities are of cultural-historical nature. By looking at the history or rather the evolution of learning activities it seems to points to a new generation with a culture where activities will be mediated by tools anywhere and anytime. Activity theory may help us to understand the culture of the "media generation" we are trying to teach.

The final part of the paper will focus on the M☺BI project itself: firstly the challenges and obstacles to overcome and secondly the implementation.

THE MOBI PROJECT
Challenges and obstacles

Technological
Platform issues: The very nature of J2ME as a scaled down version of Java, implies that its interaction with phone hardware is not quite as standardised as is the case with Java proper. Consequently it is rare for any Midlet to be equally successful across a range of cell phone platforms, without requiring at least minor tweaking.

In addition to the platform issue, content providers in South Africa have to deal with *bandwidth* issues as well. Although 3G is available in most cities the standard in rural areas remains GPRS. In addition to this, one has to deal with the fact that the majority of phones currently on the market in South Africa are not 3G compatible. In addition, until recently mobile data costs in South Africa were quite expensive. Still costs vary between ZAR1.90 (~$.25) and ZAR .50 (~$.07) for 1MB of data.
Another issue, related to the use of 3G enabled phones or non 3G-enabled phones is the kind of streaming protocol which these devices can support (Goyal, 2006).
Also, as far as Mathematics, Science and Technology is concerned, it is very difficult to envisage the proper use of these devices without an existing uniform markup language similar to OpenMath and Math Markup Language for mobile devices. The recent release of the free version of Opera Mini™ has increased the possibilities for using one of the existing mathematics markup languages for mathematics and Science education on mobile phones although this still has the limitation that learners have to become conversant with the markup language for them to be able to submit proper mathematics formulas and the like.

Educational issues

From the preceding technological issues it is clear that a mobile solution would hardly be able to replace classroom mathematics. Furthermore, the educational requirements posed by the RNCS and the OBE paradigm, which include among others interactivity, group work, a combination of formative and summative assessments, etc, simply preclude a stand-alone mobile solution. This is exacerbated by the limitations of the current state of mobile technology in the world, let alone South Africa.

These considerations aside, the RNCS, as national framework for education leading to a single state controlled final school exam, serves as the perfect point of reference for any attempt to enhance classroom learning with technology. Since the specific outcomes and their relevant assessment standards are listed by grade and subject, it is quite easy to enhance classroom learning simply by using the RNCS as basis for content development. This is especially relevant in a context where any number of handbooks is approved by the Department of Education (DOE) for a given subject, making it practically impossible to provide a solution which ties in with each available handbook.

MOBI – "interactive instructivism"

M☺BI is a narrowcast solution with some of the characteristics of a live tutor, and attempts to cover most of the challenges/issues posed in the preceding sections. Despite the technological and educational challenges, M☺BI attempts to be an omnipresent, mobile mathematics tutor which responds to and addresses specific needs, irrespective of time, place or skill level. To some extent it is also a hybrid system, in that it is available for mobile as well as PC users.

M☺BI technical specifications:
- Web-based
- Server side: MySql database & PHP
- Client side: J2ME and/or mobile browser
- J2ME framework
- Streaming/playing/buffering .3gp or .flv video

M☺BI the application has the following characteristics:
- Mobile
- Omnipresent, in your pocket, in your language
- Knows the RNCS, local
- It has a memory

The MOBI Edutainment experience

MOBI is much more than an education tool, it is a specific variation on of the "edutainment" theme, in that it provides users with MOBI Radio, MOBI Chat and MOBI Learn, all in one applet. The difference with other edutainment solutions is that it does not use games to teach, rather that it provides an environment which allows for both entertainment and education, but the learner is never expected to "learn while playing a game". Play and learn are kept separate.

MOBI maths provides learners with various options to access its content, the easiest of which undoubtedly is the 'Quick find' option where learners just submit a search term and are provided with the available content in one or more of the following modes: "Basics, Theory, Examples" and "Exercises". For Grade 10-12 learners, the first stage of the application, *Mobi Assessor* runs the learner through a multiple choice assessment in order to determine their proficiency in the subject and to establish their stage in the national curriculum. Once the learner has been assessed the Mobi application can automatically lead the learner to areas of mathematics where they are weakest – or run them through their whole curriculum for revision. Tutorials take the form of streamed videos and examples aimed at explaining precisely different maths concepts and tutorials for maths skills development.

Figure 1. The M☺BI & Maths interfaces

The "Basic Skills" section is aimed at filling gaps in a learner's maths knowledge from previous years, and will also prove valuable to Grade 8-9 learners, whereas the "Theory" section focusses on grade-specific background knowledge, complimented by the "Example" section. The idea behind the "Exercise" section is that learners first try to solve the problems posted there for themselves, before accessing the solutions offered. The "Exercise" section is in essence a preparation for tests and exams and allows learners to evaluate the depth of their knowledge.

Of particular interest to Matric learners will be the "Previous Papers" section, which contains complete solutions – with theoretical background – to the matric papers of 2004, 2005 and 2006.

Mobi is not designed to replace a teacher and classroom, but rather to enhance classroom learning by providing learners with affordable, anywhere, anytime access to mathematics instruction. It is ideally positioned to assist learners in a homework environment as a tutor to assist in the understanding of maths concepts and as a revision tool during test and exam seasons.

CONCLUSION

The South African educational landscape, like many other third world environments, lends itself to a unique solution for learner support which is affordable, independent on full-time access to the Internet via PC and available irrespective of whether learners have full time access to electricity. M☺BI is a unique mobile educational tool which delivers precisely such a solution, allowing learners anytime, anywhere access to tutoring material which is completely built on the South African Mathematics curriculum. In addition, it offers the opportunity, through its mobile chat client for one-to-one communication with an online tutor as well as for cooperative learning, while MOBI Radio enables direct audio communication in the form of narrowcast call-in sessions. The sheer scale of the MOBI maths implementation which covers the complete Mathematics curriculum for the three senior high school grades, as well as the fact that it will be available to anyone in South Africa with a Java enabled cell phone makes it one of the largest mobile education projects/tools of its kind in the world. It provides various opportunities for research on mobile learning and specifically mobile mathematics learning. In the coming months, many of these will be explored via doctoral and masters theses as well as research papers.

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CONTENT-BASED NETWORK RESOURCE ALLOCATION FOR MOBILE ENGINEERING LABORATORY APPLICATIONS

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ABSTRACT

Video transmission is required to provide a first hand experience to a distant student in case of mobile engineering laboratory. This makes the task challenging as the user has limited bandwidth. This paper presents a mobile engineering laboratory framework which provides best available quality of laboratory videos to the user in real time. Restriction on bandwidth resources at times of low bandwidth is accomplished by transmitting important parts only at a relatively higher resolution. A localized Time adaptive mean of Gaussian (L-TAMOG) approach is used to search for Motion Blocks or Visual Blocks (VBs) which are then allocated network resources dynamically according to the varying network bandwidth variations. Adaptive motion compensated wavelet based encoding is utilized to achieve scalability and high compression. Our system keeps a track of the network bandwidth and attempts to deliver the user an optimal tradeoff between important video sections and the available bandwidth. In scarce resource cases, only the most important contents of video are refreshed for the user. Experimental results over mobile engineering laboratory sequences show the efficiency of the proposed framework.

Author Keywords
Video transmission, mobile engineering lab, L-TAMOG classification, scalable wavelet based coding, dynamic network resource allocation,

INTRODUCTION

A mobile engineering laboratory is one in where one can access instruments and experimental setup over the internet. Giordano et. al. 2004 present a model that permits the sharing of costly equipment between geographically distant laboratories, as well as providing students in mobile engineering locations with access to concrete scientific instruments for mlearning applications. The earliest experiments on mobile engineering labs like Shor et.al, 2000, Akhtan, 1996 etc included robot control and circuit fundamentals. The benefits from mobile remote-access laboratory experiments for potential users include improved instruction, collaborative educational programs with other universities, enabler for distance education programs, reduced costs and improved access for the disabled as discussed in Shor et.al., 2000. Benta et. aal. 2004 discuss the importance of transmitting text, image and sound for mlearning. Our approach however, unleashes the potential of mobile engineering laboratories videos for interactive learning sessions for mobile users over a low and fluctuating bandwidth.

Various universities around the world have started E-Learning courses in one way or the other. The course content varies from only lecture slides and laboratory sheets to full video lectures. A few examples are MIT OpenCourseWare, Berkeley and NPTEL from Indian Institutes of Technology & Indian Institute of Science (IITs & IISc). However, none of these E-Learning systems has provision for any kind of laboratories. In several laboratories, the assistance required from the teacher demands more than the teacher's verbal directions.

Mobile devices bring new dimensions to vocational education. Practical principles of science, engineering and medicine are better understood by help of real life examples. When we look at the existing mobile learning frameworks or internet based e-learning frameworks, it is observed that they mainly content with disseminating text, or images related to the curriculum. Thus, the user lacks a personal hands on experience of the practical setup. Laboratories' equipment may be very costly also which may prevent students especially in developing countries from accessing them. Simulation setups have been lately made available but they are poor substitutes. They don't give the first and experience to the mobile or internet user. We propose a framework for content based network adaptive real time transmission of mobile engineering laboratory videos over the wireless and mobile networks. The proposed system analyzes the input video to split it into various Visual Blocks (VBs). The network bandwidth is tracked. The final bandwidth allocation is done to various VBs based on their significance for the user. The unimportant sections of the video frames are not refreshed in case of low bandwidth conditions.

The majority of mobile engineering laboratories use text based interface for entering input parameters and therefore are a poor replacement for real laboratories. Even GUIs without real time videos are poor solutions since the student does not get a hands-on experience of real set up. Thus, streaming videos are necessary so that the remote user gets the sense of "tele-presence" in the laboratory. Gustavsson et. al., 2002 used client/server architecture but it did not gives a first hand experience to the user as the experience is no better than using simulation softwares. A recent work by Kikuchi et al., 2004 emphasizes the need of video transmission in mobile engineering laboratories and presents an initial framework. However, their system requires a network bandwidth of 15 Mbps for efficient remote laboratory experience. Such high

Figure 2. (a,b,c,d) Sample Control Laboratory Video Sequence

bandwidth is generally not possible for majority of E-learning users. Even the theoretically available bandwidth over Broadband connection is 256 Kbps and 56 Kbps for Dial up connections which are most commonly used by personal users. We address the challenge is presenting mobile engineering laboratories videos to the user at such low bandwidth with our network adaptive coding and transmission algorithm.

This algorithm introduced in this paper is based on novel content based compression approach for real time adaptive video compression of laboratory video sequences and their effective transmission to distant user over a possibly low and varying bandwidth network. In addition to compression, we perform content based dynamic allocation of network bandwidth for video transmission to efficiently transmit region of interest. The results over control laboratory experiments' videos illustrate the efficiency of our system are quite promising.

The contributions of our approach can be summarized as follows. The proposed approach to the mobile engineering laboratory system affords making it a reality even in developing countries where network bandwidth is primarily low. It provisions for the student to conduct a mobile engineering laboratory experiment, flexibly use the camera to get a first hand experience, communicate the results and clarify doubts with the teacher. Thus the real experience can be recreated for m-learning user in case of mobile engineering labs. Most importantly, it delivers real time laboratory videos to the user with high perceptual quality.

Section 2 provides a brief overview of proposed system architecture. Sections 3 explains the working of the various modules especially the real time video (RTV) streaming. Results are illustrated in Section 4. Future work and conclusion are presented in Section 5.

2. SYSTEM ARCHITECTURE

The designed mobile engineering laboratory architecture gives an interactive interface for user and also a practical adaptive backbone framework for real time video (RTV) streaming and controls adjustments. The circuit analysis and interfacing modules are as typical and designed in standard manner and we will not discuss them in this paper in consideration of space. Our primarily focus is on RTV streaming over a low and varying bandwidth network so that the best content reception is available to the student. The following two subsections provide an overview of the outer shell and knowledge of different blocks of the system. Subsection II.A discusses the user interface while subsection II.B discusses the laboratory setup and backbone framework. The mobile engineering laboratory application is presently experimented for a control laboratory setup. Various experiments such as position control, magnetic levitation, etc. are considered for RTV streaming (see figure 1).

2.1 User Interface

The user interface is illustrated in figure 2. The user has the facility to see the laboratory video at his personal device. Various controls are provided to the user including the laboratory controls like controlling the values of Proportional, Integral and Derivative controllers if used in the experiment,

controlling the oscilloscope controls like x and y axis position, scale etc. if oscilloscope is used; reference signal used etc.

Further advanced inputs are the inputs like camera position control and synchronization and controlling the desirable maximum output video quality parameters. The video quality parameters that can be controlled include video resolution, frame rate, average bit per pixel, etc. The system has two separate connections: the first one being the connection oriented TCP connection. It is used for sending crucial laboratory information and other is control data. The second socket runs UDP based connection-less protocol for fast RTV transmission.

The processing is handled by the client processor usually the microprocessor of the available PC. The processors presently available can handle large computations; hence computational part is transferred to client side to reduce network and server overload. Thus, the processing unit performs the following operations:

1. It sends acknowledgements (ACK) or piggybacks ACK over the control information transmitted over to the lab.
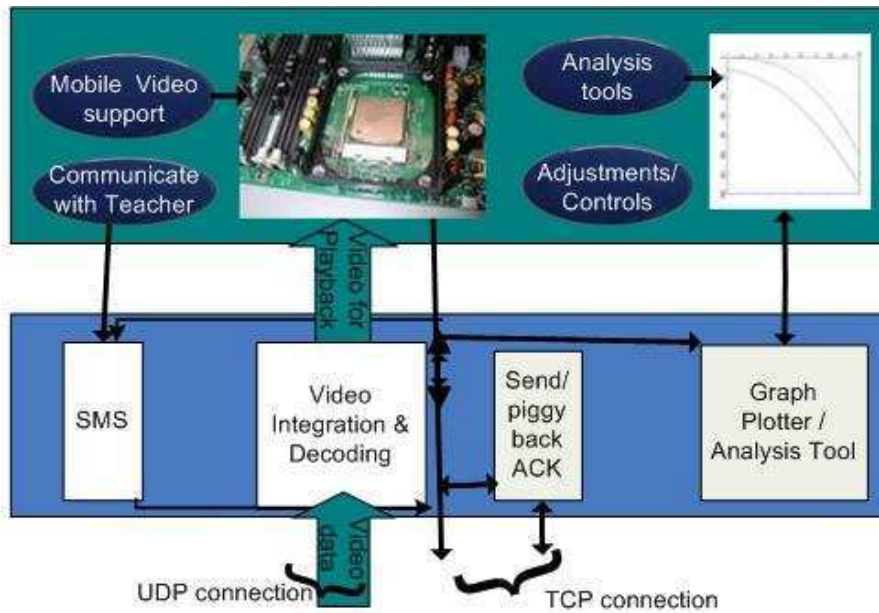
Figure 3. Interactive Mobile User Interface

   The Video is transmitted in our scheme as a combination of several visual blocks (VBs). These VBs are extracted using the localized Time adaptive mean of Gaussian (L-TAMOG) classification scheme discussed in next section. The integration and synchronization of different VBs, background and audio stream is another task for client processor. It also performs smoothening of reconstructed frames Video integration and decoding is an important function of client processor. The various inputs are plotted against each other by the graph plotter utility at user's discretion to observe the performance of system.

2. Client processor also establishes a text-based short messaging service (SMS) connection between the teacher and student if the teacher is available.

3. We provide SMS facility to the student to clear the doubts from a concerned teacher. We also incorporate the provision of transmitting graph plots back to the teacher, if required as separate stand still images.

Thus, the client processor at client side provides an efficient framework to provide the user with an interactive interface.

2.2 Laboratory Architecture

The laboratory implemented is a control laboratory and we have worked on streaming of control laboratory video sequences such as speed control, position control etc. The laboratory architecture is illustrated in figure 3. Two separate connections are maintained with the client/ user. The TCP based connection oriented connection is reliable and the information on control knobs, camera controls, user

preferences etc is transmitted over it. The UDP based connection-less link is useful for video streaming. The video packets are streamed at the estimate of network bandwidth by the Dynamic Resource Allocation block. It makes dynamic decisions on transmitting important video blocks at different bit rates. The input video from the video camera is segmented into various VBs by using a localized TAMOG approach (L-TAMOG). This approach is useful in segmenting out subtle motion in cases like position control or speed control experiments. The various VBs are then encoded using scalable CEZW encoding which enables a layered architecture for video transmission over the internet.

3. ADAPTIVE VIDEO STREAMING

The system performs adaptive video streaming. The laboratory video is transmitted at real time to the user. L-TAMOG classification enables real time classification of frame into Visual or motion blocks (VBs). Then the different VBs and the background are coded by the Scalable Video coder. The base layer Video stream is decided based on minimum available Bandwidth in the past and is transmitted. The remaining Bandwidth, available as estimated is allocated to different VBs by the Dynamic Resource Allocation module.
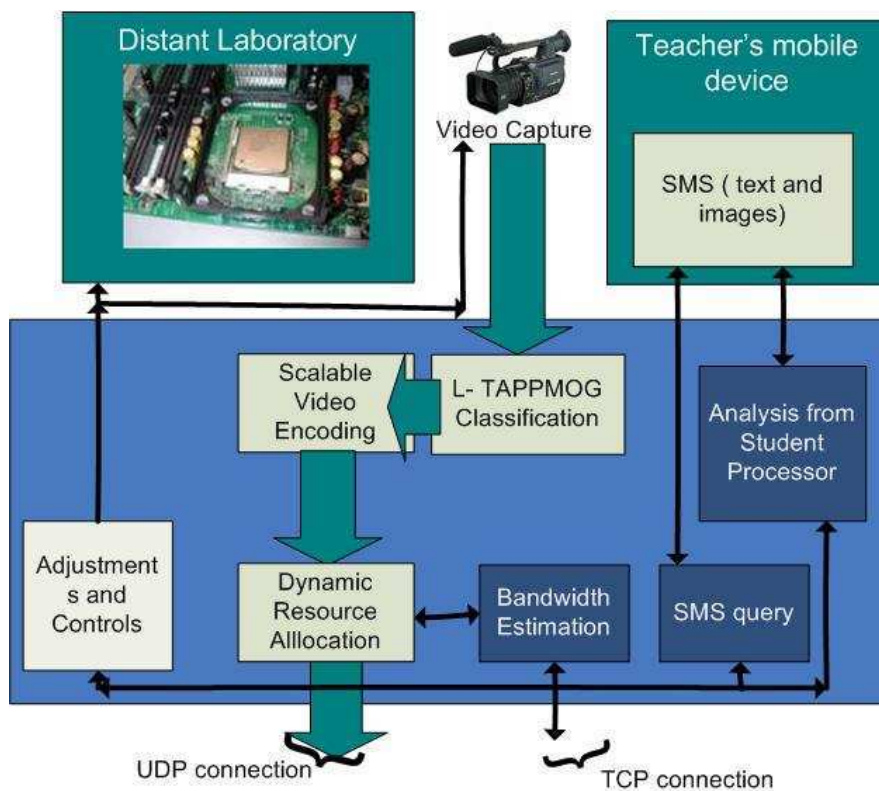
Figure 4. Block Diagram of Laboratory setup

The following subsections explain the working of each individual block.

3.1 Content Analysis Module

Since different video content requires different QoS in video streaming, the content analysis module also classifies frames into two types: motion frames and non-motion frames. Video motion frames require high image quality because the written text on board or slide is crucial in understanding the progress of experiment for the student. While for non-motion frames, a low quality is acceptable for the student, the motion frames are classified into various VBs.. The ratio of

the area of motion region to whole image area is calculated and the frames are classified by comparing this ratio with a pre-determined threshold. This approach is straightforward yet sufficiently good for such classification. The module is explained in the following subsections.

3.1.1 Teacher's mobile Access
The received information from the user is SMSed to the teacher or directly transferred to the teacher if he is physically present in the laboratory. The teacher also receives screenshots or analysis plots at user side as images if required for a detailed analysis of the problem faced by the user. This is elaborated in figure 3.

3.1.2VB Extraction
The content analysis module analyzes video content in real-time. It classifies video content into different scenes and extracts textual content. Sood et. al.,2006 models the education classroom video into various objects. However, in case of laboratory videos, the objects are unknown before hand. Hence we use a TAMOG based approach. Each frame is processed using L-TAMOG classification and the resulting regions are masked to blocks of size 8 × 8 pixels. All useful blocks are merged together to form a contiguous motion region. Topological refinement is applied to ensure a continuous motion region without holes.
Finally, the bounding box of the content region is found and matched with the previous frames in the current Group of Pictures (GOP) to ensure a constant size and reference to the VB in the GOP.

3.1.3 L-TAMOG classification
We use a real time segmentation approach to detect moving objects in the scene. In laboratory video scenes, most portion of the picture typically belongs to the static background, where the pixel value is easily estimated with the use of a statistical background model. Since real time processing is required for object segmentation, the time adaptive mixture of Gaussians (TAMOG) method proposed by Stauffer et.al.,1999 is used which is a robust and also computationally inexpensive. It is optimized for real time applications by restricting of search for maximas locally.

 In mobile engineering laboratory videos, most of the changes in the observed scene take place in some instruments, which occupy only a portion of total observed space and their position is more or less localized. To improve the run time efficiency, we have incorporated a thresholding method over and above TAMOG. The idea is simply that if a pixel value did not change over a comparatively long time period, we should consider it as static or alternatively we consider only the neighborhood of changing pixels for motion in present frame. This is applied before the Gaussian mixture process in every iteration. Since the processing is done locally as compared to global processing done in the standard method, we call our method as local time-adaptive mixture of Gaussians (L-TAMOG) method. At small finite time intervals, we refresh this localized search to include any new VB.

3.1.4 Compression Scheme
The different VBs obtained after segmentation are coded using a modified version of the CEZW algorithm researched by Delp et.al., 1999, Shen et. al., 1997, and Saenz et. al., 1999. This accounts for the rate scalability of the encoding process. The VBs are first transformed to the Y, U, V color space so that CEZW can exploit the interdependence between the colour components. The U and V components contain a high degree of redundancy and are therefore CEZW coded after 4:2:0 down sampling. Since the maximum information content is present in the Y component, it is given more importance by coding at a bit rate that is *s* times the bit rate allocated to the U and V components where *s* is the scale factor.
The compressed bit stream consists of the initial threshold T, followed by the resulting symbols from the dominant and subordinate passes of the CEZW algorithm, which are entropy coded using an arithmetic coder. The frames used for prediction of subsequent frames are decoded using the base layer data stream for the VO rather than the entire VO to ensure valid motion compensation in case of changing network conditions.

3.2 Dynamic Resource Allocation

The desired objective of video coding for real time laboratory videos is to achieve the continuous curve that parallels the distortion-rate curve with a single bit stream. A network aware content based scheme can achieve this goal. We utilize the virtues of Dynamic Resource Allocation (DRA) that adaptively manages the bandwidth allocation to the different VBs according to their relative importance and their perceptible quality. Thus the network traffic is decided based on:

a) Available Network Bandwidth.
b) Relative Motion in the VB.
c) User Preference

DRA closely tracks the unpredictable bandwidth variations due to heterogeneous access-technologies of the receivers (e.g., analog modem, cable mode, xDSL, etc.) or due to dynamic changes in network conditions (e.g., congestion events). The estimate of Network Bandwidth is based on round trip time (RTT) calculations from We illustrate our generic DRA algorithm with the example of sample control laboratory recorded videos.

The working of DRA is explained as follows:

We identify each VB in the stream in current GOP. The index i has been used for GOP number, m for frame number, k for k^{th} visual block found in the stream. Let K VBs be present in the present GOP and $k=0$ corresponds to background. Let G denotes the group of picture size. We have considered a static size of VB for one GOP and the information is sent at the beginning of each GOP. Ω_i^k denotes the relative area of kth VB in i^{th} frame. It should be noted that

$$\sum_{k=1}^{K} \Omega_i^k = 1 \forall i \in [1, GOP]$$

This ensures that the areas are normalized. The motion in each block is measured as ϕ_i^k :

$$\Omega_i^k = ar(VB_i^k)/ar(F_i)$$

$$\phi_i^k = \max_{1 \le k < GOP} abs(\Omega_i^{k+1} - \Omega_i^k)$$

where *ar(VB)* denotes the area of selected VB. The degree of motion of kth VB is used to allocating a higher bandwidth to it. We define the proportionality factor α_i as follows:

$$\alpha_i = (B_i^* - B_{bl}) \bigg/ \sum_{all k} \left\{ \left(\Omega_i^k \times (k * \phi_i^k + E_i^k) + P^k \right) \right\}$$

Here, B_{est}^* denotes the estimate of network bandwidth at time of encoding i^{th} frame and B_{bl} denotes the base layer bandwidth. P^k is the user specified preference for k^{th} VB default taken as 0.
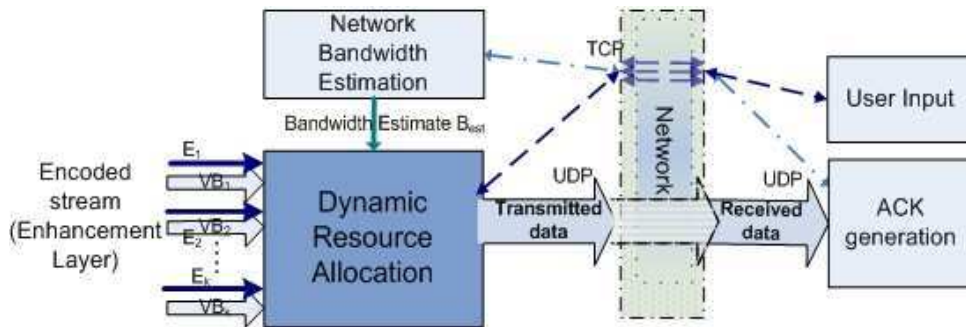
Figure 5. Dynamic Resource Allocation Scheme

E_k^i denotes the energy of the error frame (or the mean square value of error frame) for VB and hence the degree of motion in the motion block. Finally, the bandwidth is allocated using the following rule:

$$B_k^i = \varsigma \times f(i,k) \times (Q_k + E_k^i)$$

$$BW_i^k = \alpha_i * \left\{ \Omega_i^k \times (k * \phi_i^k + E_i^k) + P^k \right\}$$

where k varies over all available VBs for GOP.

and $B_0^i = 1 - \sum_{k=1}^{K} B_k^i$.

This distribution of bandwidth ensures that the higher motion laboratory events are given a higher priority during transmission and the least priority is given to static background.

This allocated bandwidth is based on present network bandwidth estimate; hence it ensures optimal network usage and prevents congestion. The use of CEZW helps in defining an embedded scalable enhancement layer scheme. The working of DRA is illustrated in figure 4.

4. EXPERIMENTS

Motion estimation and compensation blocks, CEZW coder, arithmetic coding and DDM module were simulated on MATLAB7. Results over level control laboratory video sequence has been shown. Video 2 has very few non motion frames but it requires low bandwidth for good perceptual reception at user.
Figure 5 shows the results with Level control video sequence. The required bit rate is very low for Level control video as the VB is small and remain VBs are mostly static. They however have a little non-motion frames and a constant bandwidth is required.

Figure 7 shows the reconstructed frames for various bpp for the two test videos. It is evident that L-TAMCC classification helps in selective transmission of motion region hence, higher quality video is

... algorithm over MPEG-4 and other standards illustrates ... all VBs. The Level Control Video when encoded for a ... Microsoft MPEG4 v2, 0.76 bpp for Windows media and ... ned this performance for 0.51 bpp.
... control video sequence. Results are illustrated with this ... properties. The perceptual quality of received video is ... e bandwidth is varying. The bandwidth estimation was ... work Simulator 2.0 . The PSNR of reconstructed video ... hus the viewer was provided perceptually best quality ... voiding network congestion
... is highly effective in ensuring efficient communication ... y setup.

Figure 6. Average bitrate required for Level control video for motion and non motion frames
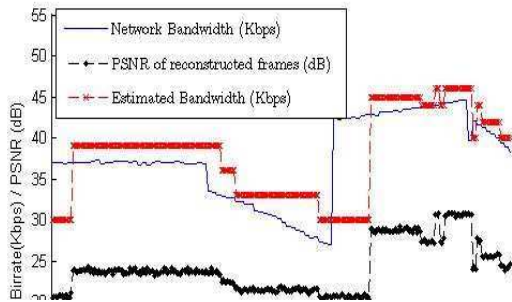
and

Figure 7. (a) Original Frame (b,c,d) Reconstructed frames for bitrate of .1, .2 and .3 bpp

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CONCLUSION AND FUTURE WORK

The proposed compression and transmission scheme promises efficient realization of mobile engineering laboratories. The students at distant places, who have access only through low and fluctuating bandwidth through mobile devices comprises of majority of mobile engineering users and they will be enormously benefited. This paper contributes a new a localized search concept to find motion blocks in low motion videos and exploits it to optimally utilize the available bandwidth to provide the client with most relevant visual information.

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A NOVEL REMOTE LABORATORY CONTROL AND EVALUATION FRAMEWORK

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ABSTRACT
A novel framework for remote monitoring and control of course laboratories has been developed. The primary focus is on E-Learning courses where holding various subject related labs can enhance the practical understanding of the subject material and students are not available locally or they want to pursue the laboratory course from their homes or university hostels. The real life competitive Laboratory environment has been simulated as closely as possible. The framework provides instructor friendly remote monitoring of lab, effective evaluation and grading methodology. The system also provides student friendly remote login, software access and problem resolution through effective help from the teacher. The system aims at taking course laboratories from the physical labs to student's mobile devices that presently include wireless enabled laptops. The framework is built on a bandwidth efficient, client-server model based backend system written in Java.

Author Keywords
Distance learning, on-line laboratory, data streaming, compression, student assistance, student evaluation

INTRODUCTION
The goal of engineering education is to develop interest and competency in technical careers and support science and mathematics education through hands-on learning. This requires all engineering courses to provide enough theoretical as well as practical knowledge of the subject material. In traditional E-Learning based courses the theory aspect is sufficient but practical aspect is missing. Locally or at distance, laboratory experimentation is a means to give a realistic meaning to theory and reveal the limitations not commonly noticeable in theory or highlight working of theoretical principles. Used before a course, labs can be used to make learners notice that their previous representation of certain physical phenomena is not precise enough or even completely wrong. Used after a course, labs can be used to master knowledge, to validate models and methods and to develop learner's behavior in a real context.

None of the current E-Learning systems have provision for any kind of laboratories. These courses are generally run in an asynchronous manner. This means the students are not required to follow any timetable and can view the lecture videos and solve the problems at their comfort. The students generally download laboratory sheets from the website and solve them on their own. However, remote labs for the case where the students are required to login at a specified common time of lab at their workplace or home are becoming more popular and desirable. Such courses are also run at multiple collaborating organizations. A collaborating organization is an organization that helps the Institute in setting up the necessary facilities and in the running of classes and laboratories for all students. Such an organization may simultaneously be also a sponsoring organization.

Sometimes in such scenarios, the verbal assistance offered by the instructor through network connection might not be insufficient for the student to grasp. A case in point is programming problems in complex software like modeling tools where verbal solutions may not work. The students in such cases generally tend to find tutorials on the Internet which consumes a lot more time than a teacher simply showing the student by his/her hand. The Remote Laboratory (RL) system described in this paper is the ideal solution for such a problem. We have interface where the all the students' screen is visible to the teacher through the network connection and the teacher can direct the students collectively or individually. Another use of Remote laboratories is in lieu of normal laboratories in case of unavailability of the instructor or students. Using the RL (Remote Laboratory) system the student/teacher can perform his/her role exactly like in a normal lab.

Despite the extensive research in the field of E-Learning, the area of Remote Labs is still quite nascent. Initially people were very skeptic of the pedagogic influences of Remote Labs. A comparative study (Corter et al, 2004) gave encouraging results and boosted the implementation of Remote labs at various places. A great amount of progress has been made in the area of computerized control of various industrial electronic devices for e.g. work by (Bi et al, 2007). (DePellegrini et al, 2006) proposed the

usage of wireless networks for the device level communication of automation systems. Shared-Laboratory (Fujii et al, 2005), a remote laboratory system, for digital circuit experiments employs a time-sharing fashion to make students at remote sites perform actual experiments using actual hardware equipments and tools concurrently; hence preventing the wastage of precious time the resources that are available. Shared-Laboratory employs shared resources, and enhanced service management scheme based on the Web Services. (Bagnasco et al., 2004) present a versatile remote laboratory that models distributed environment characterized by a double client server structure. It consists of a main Virtual Laboratory Server (VLS), a network node hosting a web server that introduces users into the virtual laboratory, implements the access control policy, and logs users' activities, and one or more Real Laboratory Servers (RLS), an application server that can be spread on wide geographic area and control real experiments. The users can work in a way transparent to the real location of the device under test, in a multi-user concurrent way. The AIM-Laboratory (Automated Internet Measurement Laboratory) provides real laboratory experiments via the Internet (Shen et al, 1999) and reports positive experiences. TIPY (Leleve et al, 2003) makes Programming Logic Controllers from Schneider® reachable by any host from Internet using web interface consisting of PHP pages run by APACHE web server and linked to a MySQL database server and adds a system to load and unload the store at distance. Another impressive work is the German e-learning project CONTROL-NET (Langmann, 2004) that was developed and used for internet-based, multimedia supported teaching and learning methods in control and automation technology for the engineer-technical education.

The proposed approach to the RL system is quite different. It has various instructor and student friendly features besides allowing a competitive exercise for students. Instead of simply allowing access to the Laboratory equipments it simulates the actual Laboratory environment by providing the students an invigilator and by providing the invigilator an evaluation and grading mechanism that makes the remote laboratory as competitive and as exciting as a real laboratory. Most importantly it is highly bandwidth efficient allowing students to participate in labs even from far-off places with no broadband connectivity. The system can be applied to all Computer Science labs; Microprocessor and VLSI design labs; CAD/CAM lab, Process Computational Fluid Dynamics Laboratory and various labs which use Matlab, Simulink, etc. or any computer controlled analysis system.

The system uses Java for both the client and server side. Java is the natural programming language of choice because of its platform independence, flexibility of GUI design and a vast and easily accessible network programming API.
In the rest of the paper the system architecture is presented. Section I provides an overview of the remote laboratory framework. Details of the system architecture are provided in section II. Experimentation results and details are presented in section III.

I. REMOTE LABORATORY FRAMEWORK OVERVIEW
The proposed RL laboratory framework provides complete management and control of labs. It allows students and instructors to login remotely from their homes or hostel rooms. A brief block diagram of the system is shown in Figure 1.
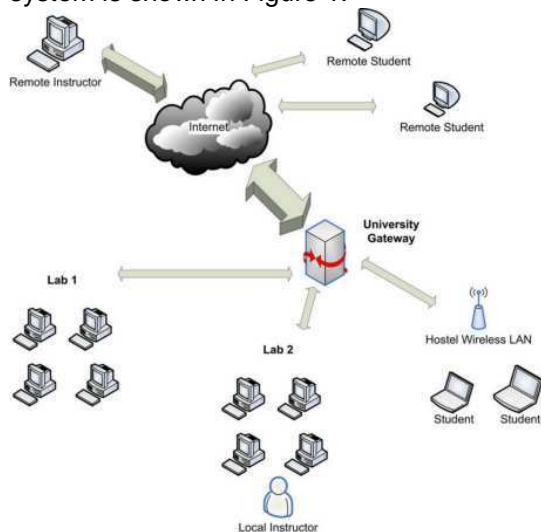
Figure 1. Block diagram of RL architecture.
The teacher's interface allows him/her to view all student screens as thumbnails during the period the student stays logged in. This allows maintaining decorum in laboratory and prevents casual copying as the students know that they are being monitored. The teacher can zoom into any student's screen and get the full view of the screen. From here the teacher can make a connection to student's computer and resolve doubts. The student's application constantly monitors his/her computer and sends screenshots to the teacher's machine. The student can also initiate a doubt resolution request to be handled by the teacher.

II. DETAILED SYSTEM ARCHITECTURE
The architectural and implementation details of the various components of the system are described ahead.

Student System
The student application is the software program that the student will start when he wants to participate in the lab. A student will login into the laboratory at the specified time to start the screen capture system. The screenshots are converted to thumbnails by the system and sent to the instructor's computer (henceforth server) at a rate of 1 thumbnail per 2 seconds. This limit was determined experimentally and it allows the system to consume very low bandwidth and transfer considerably important laboratory events which is one of our primary concerns. The image file format for the process was chosen as JPEG after a subjective comparison (Bojkovic et al, 2001, Cruz et al, 2000 and Lins, 2006). The subjective results were verified to be mostly correct in the experiments, (see section III).

The student can also request a connection with the server (Raise Hand action). This action can be taken either to ask a question from the instructor or to inform the instructor about successful completion of Laboratory assignment. After the teacher accepts the request the student system starts sending full resolution screenshots. This requires high bandwidth on the student side. The image streaming algorithms presented by (Chiu et al, 2000 and Hu et al, 2004) yielded good quality in low bandwidth but were extremely high on required processing power. Especially in the case of using heavy modeling software the student system was unable to run the algorithms in the background. The work by (Deshpande et al, 2001) provides a good scheme but it was not designed for remote laboratory therefore there was scope of improvement. Hence, a unique strategy has been applied to reduce the bandwidth requirement without hogging up the student's computer system. The new connection has some specific requirements and hence it has some special properties that can be utilized to reduce required bandwidth. A full resolution movie with 30 frames/second is not needed because the rate of change of source is not that high. The user can select the resolution for each screenshot. Since the application is not time critical, the screens are buffered for 5 seconds before being sent. Each second 2 screenshots are taken so the buffer contains 10 screenshots. The following algorithm is applied to the screenshots:
1) An array of 10 adjacent screens named S is created. Two screens are adjacent in the array only when they are temporally adjacent. Timestamps are added to all the screens according to the time the screenshot was taken. These timestamps will be used on the server to display the screenshots in a synchronized manner. The pixel difference between all adjacent frames is computed. D_{ij} is the number of differing pixels between two frames i and j.
2) The *threshold* is set to 1% of the present resolution. Experimentally, this threshold shows good output for text editing as well as graphical changes on screen.
3) While $i = 1$ to 10, $j = i + 1$; If $D_{ij} < threshold$, Screen S_i is removed from the array. Hence $S = S - S_i$.
4) The screens are shifted into the empty slots, hence created. If no empty slots are present, the buffer is transmitted to the server; else, Step (3) is repeated.
This technique reduces a considerable amount of data transfer without putting overload on either the client or the server. The system at the Instructor side which receives and processes this data is described in the next subsection.

Instructor System
The Instructor's application is more complicated than the student system. It also requires high bandwidth and good processing speed. This was deliberately done to shift the load from the student side to the instructor side. As the laboratory starts, the system shows the thumbnailed windows of students logged into the system as shown in Figure 2. The thumbnails are identified at connection request and associated with student's enrolment numbers. The instructor simultaneously monitors all the students' screens. The minimum bandwidth required by the instructor system for this purpose is the product of the

number of students logged in and the bandwidth required for transmitting each thumbnail. This is also the reason why the thumbnails stream is not processed before sending.

(a)   (b)
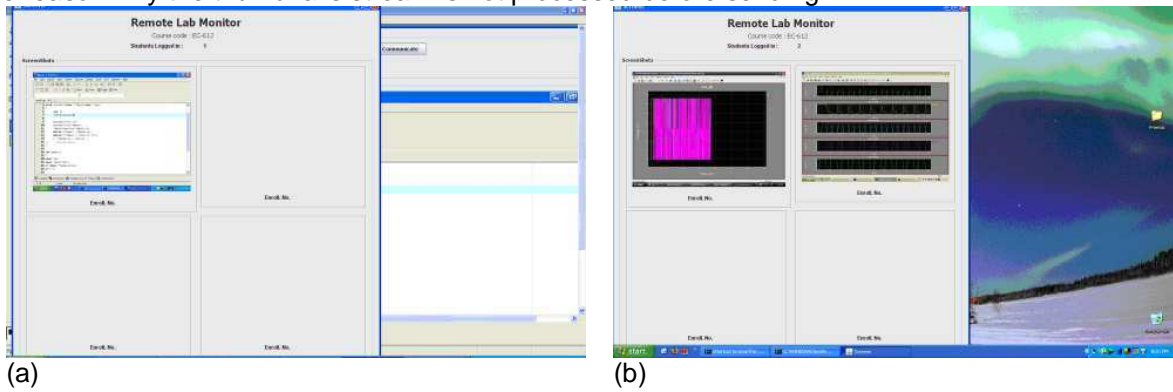
Figure 2. (a) RL Monitor with one Programming lab student logged in; (b) RL Monitor with 2 VLSI Design lab students logged in.

Applying the reverse decoding process in that case requires extremely high processing power from the workstation and slows it down considerably. Figure 3 shows a detailed overview of the complete process from student to instructor at glance.
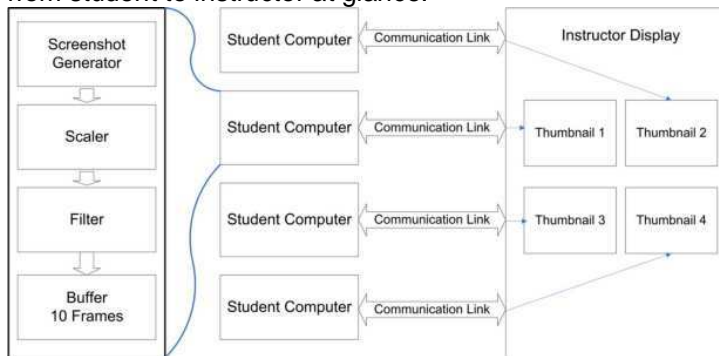
Figure 3. Flow diagram of RL monitoring system.

Once the instructor selects a thumbnail and opens up the new screen the system starts receiving the detailed screen buffer from the student system (henceforth client). This is as shown in the sample screenshots in Figure 4. The buffer initially had 10 screens as it waits for 5 seconds with 2 screens per second but the buffer received after applying the scheme may contain from 1 to 10 screens. These screens contain timestamps that were added at the client side. The following algorithm is used to display the screens in a time synchronized manner.

1) The received screenshot buffer has already been sorted at the client side so the first thumbnail, the one with the lowest timestamp, is displayed.

2) The difference between timestamps of two adjacent screens is calculated. $t_d = t_{i+1} - t_i$, where t_i is the timestamp of frame i and t_d is the difference in timestamps.

3) The system waits for time interval t_d and displays the next screenshot.

4) The process is repeated till the buffer is empty.
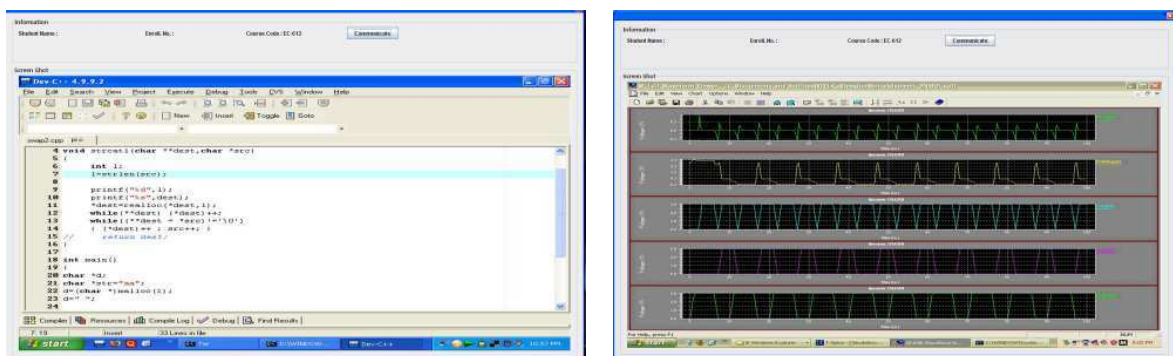
Figure 4. (a) RL Monitor with one Programming lab student logged in; (b) RL Monitor with 2 VLSI Design lab students logged in.

The instructor can also establish a connection with the student on the detailed monitoring screen. This connection allows the instructor to talk to the student using Voice over IP. This can be utilized either to answer a raise-hand request or to ask a question as part of the laboratory grading process. For e.g. in a programming oriented laboratory the instructor can ask the student to explain the particular code he has just written and grade him accordingly. The assignments can be reviewed by the teacher remotely just like real laboratories.

Remote Controlling System

The remote controlling system is essentially important in modeling labs where verbal communications are not of much help. Figure 5 explains the basic working of the remote controlling system.

When the remote controlling system is activated the student is allowed to view a trial solution at the screen and understand the solution to his problem. The input controls at the student system are deactivated. The previous algorithm, used for transmitting detailed screenshots, is not applicable in this situation because of considerable time lag. The time lag prevents synchronization of the two screens and creates an awkward environment. The procedure used for this system needs to be very simple to prevent any delays. The procedure is explained ahead.

1) The pixel difference between two adjacent screenshots is computed.
2) If the difference is 0, the first screenshot is rejected.
3) If the absolute difference is > 0, the first screenshot is transmitted to the server side.
4) Second screenshot is now the first screenshot and the new screenshot is the second screenshot. The steps are repeated.
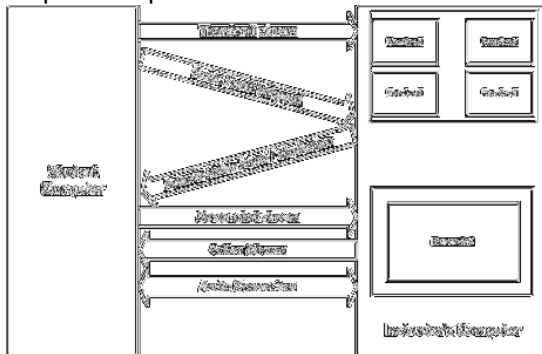
Figure 5. Flow diagram of RL remote controlling system.

This procedure again reduces the load from the student side. At the instructor side also the screenshots are simply displayed in the order they are received without any extra processing. The extra thing required at the instructor side is to send the messages from the input devices to the client side. When the student window is in focus, all input actions are simply redirected to a stream and transmitted to the client side. At the client side the redirected input to be taken from this stream.

The results are displayed in the updated screenshots at the instructor's machine. This make the instructor virtually control the remote students computer. Since the student does not require seeing the complete movements of the mouse, the mouse co-ordinates are transmitted only when a button is clicked. This allows the instructor to perform all the basic tasks like mouse button clicks and even advanced ones like drag and drop without actually sending all the co-ordinates.

The system works as a protocol designed over the basic client server model. It was initially designed in Microsoft Visual C++. But seeing it's application (laboratories can have computers with various environments), it was ported to Java using JDK 5 enhancing its platform independence. For, the basic image processing functions and algorithms Java Imaging API was used. The voice part was an add-on built using Java Sound API and Java Media Framework.

III. RESULTS

The remote lab system was tested with various image formats to choose the most suitable one. Figure 6 shows a comparison the bandwidth required by basic monitoring system at student side. GIF images provided very bad quality especially in case of modeling applications as GIF makes high color approximation. Finally JPG was selected for thumbnail monitoring purpose in the system.
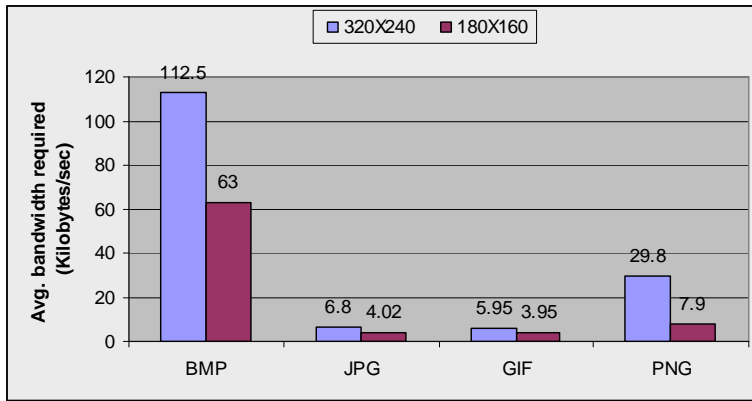
Figure 6: Comparison of bandwidth required by basic images formats and sizes.

The tests for average buffer sizes for transmitting the detailed student screen were conducted on a number of cases to yield interesting results. Figure 7 provides a comparison of average buffer sizes for transmitting the detailed student screen for the cases of a generic C++ lab and a Computer-aided Design lab. The difference in requirements of bandwidth is attributed to difference in laboratory setup. The relative performance of image formats also varied. We thus selected both JPEG and PNG for transmitting the detailed student screen. The screenshots in the both the cases were taken with the resolution set to 1024x768.

From the results, it is clear that for different applications different image formats provide best results. Hence, an option was added to the system for transmitting the thumbnails in PNG or JPG. This allows the students and instructor to select the optimal format beforehand.
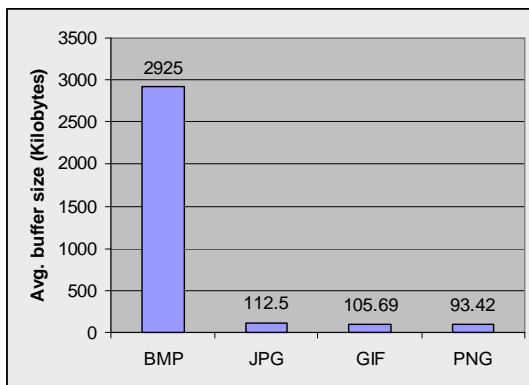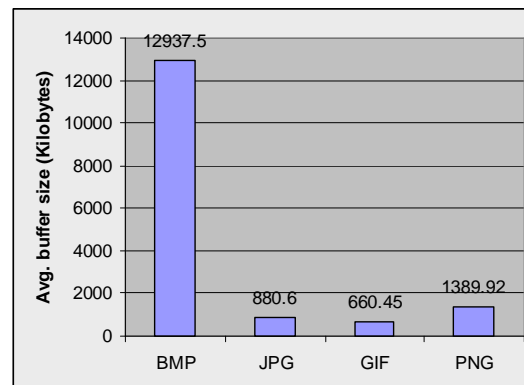
(a)   (b)

Figure 7: Comparison of Average buffer size in (a) Programming Laboratory and (b) Computer-Aided Design lab while transmitting detailed student screen using various image formats.

CONCLUSIONS

In this paper, a framework for remote monitoring of course laboratories was presented. The RL system allows full control of laboratories by the teacher who can be on a remote location far away from the physical laboratory. The system allows the teacher to properly evaluate and grade students over the internet or intranet. The system allows students to participate from anywhere with his computer wirelessly connected to internet. The system is highly suitable for usage in a mobile environment as it has low bandwidth requirements. The system can be extended to allow laboratory examination as well. The system's pedagogic abilities can be further demonstrated after a considerably long period of usage in lieu of or in addition to a normal Laboratory course.

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SELF-ORGANISING M-LEARNING COMMUNITIES: A CASE-STUDY

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ABSTRACT

This case study applies a 'living systems' theoretical model for m-learning community formation (Nalder & Dallas 2006) to an early intervention learner driver education program. The program, for 16 year olds, targets hazard perception ability, attitude, and behaviour as key contributing factors in crashes.

The paper focuses on a key phase in the program (in-the-field learning episodes and self-reported driving behaviour) for which tools were designed utilising available context aware and location related applications for mobile devices. Choices are rationalised in terms of applicability to education for meta-cognitive development, capacity for user self-management, and adaptability. These criteria were essential as subsequent research phases involve measuring and reporting on medium and long-term impact (up until age 25). The implications of two emerging trends are considered: firstly, the proliferation of Application Programming Interfaces (APIs) for diverse devices that are designed to grow internet-supported m-commerce, and secondly, the broader uptake of new on-line genres that has created more accessible spaces for social interaction. The paper concludes that these trends are more effectively considered by education designers from the perspective of how they are or may be co-opted and creatively adapted by the user.

Author Keywords
sustainable m-learning communities, living systems, self-organisation, context-aware, location-based software, m-learning tools

INTRODUCTION
Purpose:

The purpose of this paper is to present the results of a study that sought to test the viability and transferability of a systems theoretical model for the formation of self-organising m-learning communities (Figure 1, below). The model, which was devised for use in institutional contexts with www-based learning management systems (LMS), was premised on two notions. The first was 'swarming' - a metaphor for mobile-phone-user social behaviour borrowed from the biological sciences. The second was the interoperability and adaptability for learning purposes of Application Programming Interfaces (APIs) already in use for other services (such as 'pushing' information about restaurants to users based on their proximity to a particular geographical location, or matchmaking based on a personal preference profile).

The following sections provide, in order, (i) the study background which explains the context for the study and the influence of context on outcomes; (ii) the overarching research methodology – a fusion of Multiple Perspective Analysis Convergence (MPA-C) (Ecker & Baker, 1984), Participatory Design (PD), and Philosophic Inquiry (PI); (iii) the results, in terms of technologies, applications, pedagogical strategies and learning tools; (iv) the discussion of the results, relative to the key concepts – self-organisation, sustainability and transferability; and (v) conclusions – summary of achievements and contribution to new knowledge.

Background to the case-study

The context for the study is a community-based early-intervention Young Learner Driver Education Program (YLDEP) for 16 year olds. This was not the context for which the self-organising m-learning community model (Figure 1 below) was devised. This model was devised for adult learners seeking undergraduate or postgraduate qualifications through an Open University Network. However an opportunity arose to test the model on a not-for-profit Community-based Education (CBE) program, resulting in a significantly different, but productively challenging context for the proposed pilot study.
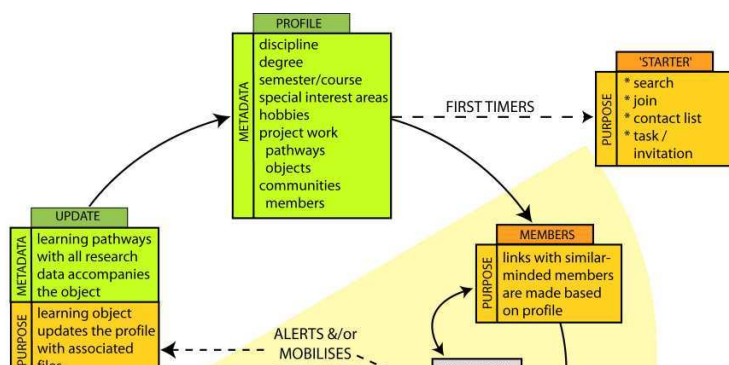
Figure 1. Model: Self-organising M-Learning Communities.

Three key features that distinguish CBE from Community Education (CE) and Institutionally-based Education (IBE) had an influence on the study outcomes. These were (1) that CBE is primarily "a form of social action within a community framework that extends beyond schools as institutions"; (2) that CBE is considered empowering, in that it "allows community members to become self-oriented participants in the creation of the learning environment"; and (3) that the form of CBE is likely to be "more dynamic" (than either CE or IBE) (Corson, 1998:238).

The advantages of these three features for this pilot study are (1) that many of the barriers to experimentation leading to educational innovation are institutional, and while educational institutions seek to empower learners, it is often difficult to achieve learner empowerment because of systemic and regulatory constraints; (2) that self-orientation in participation (a characteristic of CBE) is highly compatible with self-organisation – an aim of the model; (3) that the dynamic form attributed to CBE was characteristic of the YLDE program, which operated via feedback loops between community resident experts, the participants, and the researchers, (as the University is located within, and considered part of, the community). This meant that the program was not a 'closed' system. The program's flexibility and openness to adaptation are characteristics of 'living systems' that are essential to its sustainability. Along with transferability, sustainability is an important goal for the YLDE program.

Thus the intentions for the YLDE program were clearly sympathetic to the model that the study sought to test. So the CBE context can be seen to advantage and simplify the study by eliminating some of the more difficult challenges to the model that would certainly have arisen in an IBE context. Further, the CBE context directed the study toward the examination of user-side, rather than provider, or server-side applications. And, while this may be perceived to be a limiting factor in terms of IBE interests, it is possible that this direction may be a consideration when Open Learning Institutions seriously embrace m-learning. Therefore a key task for the study for the IBE context was to consider the viability of assessment that is based on learner participation and learner-data-based evidence, in conjunction with other strategies that cater for learner-centredness and mobility.

The formation of self-organising learning communities is an important phase in the YLDEP, following the initial 10-module workshop program delivered to 16 year olds in community and school settings. The community workshops cater for young people who do not attend school. Workshops are also held for parents, carers or mentors who will be supervising the driving practicum. The m-learning community formation begins after the workshop program when parents, carers or mentors drive learners on local roads as their complete the post-course learning assessment task, which tests their readiness to apply for a learner driver permit to begin their practicum. New regulations apply to practicum that require learner drivers to log 100 hours of supervised driving pre- and post-license. Thus a tool for logging (or blogging) self-reported data would be advantageous. As well, the necessity to maintain open communication channels on completion of the face-to-face workshops is crucial to the proposed longitudinal study that will evaluate the YLDEP's long-term impact by monitoring the driving behaviour and records of participants until they are 25 years of age.

METHODS
Methodological Framework
The case-study – a pilot trial of tools and a model for self-organising m-learning community formation - is part of the formative evaluation phase of the YLDEP, and sits within a larger research program that culminates in a longitudinal study. Ecker & Baker's (1984) *Multiple Perception Analysis Convergence* (MPA-C) *model* was selected for the formative evaluation phase for two reasons: firstly it supports the

collection and analysis of data derived from qualitative and quantitative evaluations of education programs, and secondly, because it attends not only to the educational, but also the social, and psychological dimensions of a learning situation. This aspect is important given the focus of the YLDEP on behavioural change. As well, the MPA-C model is responsive to changing educational contexts. Thus it is, arguably, suited to the dynamic and multi-layered YLDEP, which is the context for this study.

YLDEP is taught by a team of professionals from several disciplines in diverse contexts e.g., students in schools who are about to become learner drivers, as well as learner-drivers and parents and/or carers of learner-drivers in community contexts. The MPA-C model is suited to this context because it teams outside evaluation specialists with stakeholders in the development and delivery of a program to record the perceptions of all participants in a non-hierarchical format, for subsequent subjection to a cross-disciplinary analysis. Inter-subjective verification of perceptions is then achieved through independent reviews of audio and video recordings, interviews, observations, and questionnaires. Converging and diverging perceptions are then submitted to program members or participants for their responses, and the final multiple perception analysis (MPA) is submitted to an additional outside review panel of 'critical friends'. Responses to open-ended questions were analysed using Leximancer™ software to quantify data generated via qualitative methods. Leximancer™ is a qualitative research tool that uses semantic mapping to develop concept maps from natural language. The concepts identified through this analytical software are graphically presented to indicate the relative importance of, and interrelations between, concepts. Subsequent breakdown of data in terms of discriminating, stable and multivariate indices provides a means to identify skill and knowledge base development; and to distinguish variances between contexts.

Embedded within the overarching MPA-C model are Community of (Philosophic) Inquiry (PD-CPI) methods (Nalder, 2004), explained in detail below. The PD-CPI method supports the simultaneous development of an education program while enhancing the learning outcomes. It does this by engaging participants in 'authentic' learning experiences that involve them in the generation of content and resources pertaining to local contexts that illustrate their understanding of concepts.

Participatory Design

End-users (adolescent learners) have been involved in the YLDEP design from the outset, via a Participatory Design (PD) process. For example, participants were involved as actors in the production of interactive learning resources for the LDEP with professional and young student film-makers and animators from the University's Film School. User-feedback elicited through an inquiry process (explained below) has been incorporated into each phase of the program.

PD was pioneered in Scandinavia in the 1960s by computer systems engineers, who used a 'collective resources' approach to systems development that involved end-users and unions in the design process, recognising "the importance of perspectives, interests, conflict and participation among multiple expertise standpoints in the design process" (Levinger, 1998). More recently, PD has adopted ethnographically informed strategies, including 'cultural probes' to engage user groups through the introduction of 'artifacts' that encourage interaction so that multiple perspectives can be considered and conflicting views expressed in non-threatening contexts. This strategy was used in post-course evaluations to generate rich data for subsequent analysis. Although PD is an important break-through in terms of *recognising* user perspectives, recent education research has shown that programs that *involve participants in 'authentic' experiences* (rather than in simulations or games) lead to deeper learning. Therefore the post-workshop activities around which the m-learning community is formed are undertaken 'in the field', and constitute the application of classroom-based learning experiences in 'real life' contexts.

Community of Inquiry Process

A Community of Inquiry (CI) approach was adopted from the outset that engages research and development groups and program participants in interactions that differ from the standard model used to address research questions or problems. The CI approach addresses three elements: *domain, community, and practice* (Wenger, 2001). Integral to our adaptation of this approach is the process of Philosophic Inquiry (PI) whereby *the question itself* is the discovery of the subject. This process involves the community of learners in the analysis of concepts through externalised group thinking. Interdependent thinking is then internalised into individual thinking. The participants discover and/or unpack the question for themselves, leading to a more focused and reliable outcome. (PI is an approach

to learning based on the work of Lipman in the 1970s to develop higher order thinking skills and deep co-operative learning). This process also underpins the approach to the activities that engage YLDEP m-learning community members in on-going self-reflection and self-reporting.

Selection and role of case-study participants
The YLDEP engaged adolescent participants in a 10 module 2-day workshop program, and parent-carer-mentors in a separate 3-hour workshop, both delivered in dual contexts: school and community. The 10 participants in the m-learning community case-study are graduates of the first community-based workshops undertaken in the program's 'home' community, who volunteered to participate in the long-term research program. They are in the second phase of the program, which engages learners and driving mentors in the 'in-the-field' application of the knowledge they gained through the face-to-face workshops. In this phase, learners are driven by their mentors on a local area route mapped by resident professionals from the fields of policing and ambulance services. The route is devised to maximize their encounter with known road 'black spots' (sites of frequent serious road accidents). Tools are provided to enable the learner drivers to record their responses using mobile devices for subsequent upload to their blogs, where feedback is provided on their readiness to proceed to the next phase (supervised driving practicum).

RESULTS
The results of the m-learning community formation case-study are reported below. Aspects covered are, pedagogical strategies, m-learning tools, technologies, and applications; social networking tools and spaces.

M-Pedagogy

During the past five years education researchers interested in exploring how the use of mobile devices by learners can be accommodated have emphasized the necessity for pedagogy to co-evolve. Syvanen & Nokelianen (2004:191) undertook an extensive review of mobile learning materials and environments using an on-line tool to develop their Components of Mobile Learning (CML) model, which listed the following 10 criteria for pedagogical usability: learner control, learner activity, cooperative learning, goal orientation, applicability, effectiveness, motivation, valuation of previous knowledge, flexibility, feedback. While these criteria could equally apply to learning in static contexts, they do provide a useful checklist for consideration in terms of how these criteria might become essential attributes of the conditions required for m-learning community self-organisation. To achieve this, consideration was given to how the cultural and social as well as the technological specificities of the mobile mode of communication could be co-opted for the development of tools for self-managed learning in the post-workshop (in-the-field) pre-practicum phase. These are detailed below.

M-learning tools

The first consideration in the development of the m-learning tools was that they should be purpose- and usability-driven. Purposes were to:

(1) collect evidence-based data about impact of phase one of the YLDEP on participant cognition, attitude and behaviour on the basis of the practical application of learning "in the field" in an manner that is likely to engage participants and sustain participation;
(2) build in assessment instruments (e.g., the digital field journal) that will position the YLDEP within the category of "structured community-based courses" for accreditation toward a senior school certificate; and
(3) provide a 'proof of concept' for the next phase (supervised practicum log).

In keeping with the PD process through which the program had evolved, user groups participated in the design of the tool – a digital field journal for recording evidence that graphically demonstrated their ability to meet the road-readiness criteria for obtaining their learner-driver permits and beginning their supervised practicum. Learning undertaken in workshops was applied to a local area map with a pre-determined route comprising a variety of road types and terrains (e.g., urban and rural conditions, speed limitations and surface types and hazards including rail and school crossings) to be driven along by the parent-carer-mentor with the learner as passenger. Freely available device and context aware resources to support this task were identified, and are outlined below.

Freeware m-learning resource options:

1. Google Maps
Google Maps, a recently available mapping service, provides access to maps with landmarks and satellite imagery as well as generating driving directions. Users are able to create their own maps (mymap) to which they can add their own landmarks or points of interest. Text descriptions and photos can be added (with a little HTML knowledge). Once a map is saved it is assigned a unique URL. This service could be used in two ways on mobile phones.

Maps for mobile, a downloadable application, functions on most Java-enabled (J2ME) mobile phones, Palm devices with Palm OS 5 and above, all colour BlackBerry devices, and Windows Mobile devices with Windows Mobile 2003, 5.0 and above. (http://www.google.com.au/support/mobile/bin/answer.py?answer=40662)

Mobile Web, accessible by any Internet enabled phone enables users to visit mobile.google.com/local on their mobile browser. Once there, they could search for landmarks, view maps, and find driving directions. (http://www.google.com.au/support/mobile/bin/answer.py?answer=40662)

GPS technology Google Maps for Helio subscribers and for Windows Mobile devices (regardless of provider) were enabled with GPS. However when accessed by other devices Google Maps did not use any GPS technology, even if those phones had a built-in GPS location device. (http://www.google.com.au/support/mobile/bin/answer.py?answer=39894&ctx=sibling)

Google Maps is a free service, but use involving telcos meant that rates applied. However, this could be overcome if users accessed *google maps* from a web browser on a standard computer, via http://maps.google.com.au/

2. Whereis
Whereis, an Australian mapping service that sources digital maps from UBD (the largest publisher of mapping products) could be accessed in two ways: through either a web browser, mobile phone or GPS navigation system.

Whereis® Navigator - an application that operates on compatible mobile phones and personal digital assistants, provides access to *Whereis* Map Data and points of interest. Specifications include Software CD, unique license key, GPRS or CDMA 1X/eVDO data connection; Bluetooth or Serial GPS Receiver (NMEA compatible should work correctly however Sensis only supports approved GPS Receivers.); 3MB memory free. Models supported include Nokia 6600; Nokia 7610; Siemens SX; iMate PocketPC; iMate Smartphone2; XDA I & II; HP iPaq 4150 & 2210 (in combination with wireless data connection); iMate JAM; iMate Smartphone, SP3 & SP3i; iMate PDA2K; HP iPaq 6315 series; Panasonic x700, and Telstra – GPS enabled devices.

Whereis Mobile allows users with any internet enabled phone to visit http://mobile.whereis.com for access. Once there users could get directions, look at maps with points of interest and locate a range of nearby services. Telstra customers were able to invite their friends who are also on the Telstra network to join Whereis® *Everyone*, enabling users to find the approximate location of their friends at any time. Although *Whereis Mobile* works on any Internet enabled phone, data service rates apply from telcos: http://www.whereis.com/whereis/personalMaps/whereisMobile.do.

Whereis API, a commercial API, provides the means to publish maps, directions and embed location-based services into business application and websites. As the name suggest, this is generally a commercial service but *The Whereis Workshop API* is available to individuals seeking toThe basic features of this service are the ability to generate maps centered on specific street addresses with embedded icons representing businesses or other points of interest and specific route maps and turn-by-turn instructions between one street address and another: http://www.whereis.com/whereis/businessSolutions/navigationApi.do

Telstra and Whereis Telstra offer *Whereis* as a service on their next G network, with options for a pay-per-use cost of approximately AUD 1.25 to view a map, or a data package (ie 10mb download for AUD16/month).

Figure 2. Digital field journal: interactive road map with participant-inserted road hazard identifier, tagged with risk assessment entry.

Figure 2 (above) illustrates the use of an interactive mapping system for the field journal process. The interactive local area map with the prescribed driving route was made available to participants in various formats using the map generation and mash-up facilities accessed by the program developers (on the basis that the CBE program was a not-for-profit community service.) Participants were required to complete a field journal in order to demonstrate their readiness for obtaining a learner driver permit and undertaking the pre-license supervised practicum. The field journal tasks were:

(a) locate a hazard that required driver decisions

(b) record the road rule(s) to be followed

(c) state the appropriate driver attitude or modification to driver attitude

(d) (d) state the appropriate driving behaviour and/or modifications to driving behaviour required in response to the hazard

(e) identify the potential consequences of not modifying driving behaviour and

(f) record incidents of inappropriate (risk-taking) driving behaviour they observed during the journey (whether by their driving mentor, or other road users).

Their location on the readiness matrix scale was subsequently assessed, and feedback provided, on the basis of their recognition of applicable road rules, hazard recognition, and appropriate risk avoidance behaviours on the pre-determined route map hazard checklist prepared by the program development and teaching team (expert professionals in the fields of policing and ambulance services).

Participants were also provided with hard copy print-outs of the area map and field journal entry sheets, and were asked to photograph the "black spot" locations using mobile phone or digital cameras. This strategy aimed to provide options for participants to use tools of preference to record their field observations.

Learner-managed Social Networking tools/spaces

A characteristic of CBE is its reliance on freely provided support from within the community or sponsors. Transfer of the YLDEP to different community contexts will result in variable conditions. Therefore technology is more usefully understood as 'idea' rather than as 'object' or 'thing'. This suggests that usability criteria that is applied in IBE contexts, such as that derived by Syvanen and Nokelainen (2004:191) (accessibility; 'learnability'; memorability; user control; help; graphical layout; reliability; consistency; efficiency; memory load; errors) are best considered by the user rather than the provider on the user's behalf. Thus in a self-organising CBE situation, decisions about how data could be protected and maintained for the life of the research program are important. It is anticipated that participants would upload their field journals to a YLDEP website hosting blogging facilities, including the field journal structure and feedback report for program participants. A code of conduct and access privileges would need to apply. The community-based teaching team would assess the submissions and provide feedback and rate the response on a "driver readiness" scale.

The following overview of social networking tools and spaces is undertaken from the perspective of youth participation in Internet culture. While adolescents are accustomed to using or accessing sites created using a wide variety of freely available tools and spaces such as *Wikis, Blogs, Internet Forums, MySpace*, or photo and video sharing sites, CBE program convenors may be less likely to be familiar with these. A review of social networking tools and spaces was therefore conducted as background research to the study. Results were as follows:

Wikis
A Wiki is a website that is able to be collaboratively edited by its users, who are also able to alter each other's texts. Wikis can also include features such as calendaring, discussions, to-do lists, file uploads including images for image galleries. There are many publicly available "wiki farms" that enable anyone to create their own wiki, and, depending on the service, the wiki can be open to public access or be password-protected for privacy. A disadvantage of free wiki farms is that they generally contain advertising on every page. However it is possible to build a wiki using open-source software and host it privately.
Reviews of wiki farms can be found at http://en.wikipedia.org/wiki/Comparison_of_wiki_farms.
Comparison of wiki software can be found at http://en.wikipedia.org/wiki/Comparison_of_wiki_software

Blogs
A blog or web log is an online diary of sorts. It is essentially a website that allows users to add text entries and others to leave comments. Some blogs allow upload of images. Popular free blogging tools include *blogger* and *wordpress*. *Blogger* is a free web-based tool for instant web publication. *Blogger Mobile* allows users to update blogs via MMS or email. This is not supported in Australia yet but indications are that it will be soon.

 Internet Forums
An Internet forum is an online discussion group also referred to as web forums, message boards, discussion boards, (electronic) discussion groups, newsgroups, discussion forums and bulletin boards. A sense of virtual community often develops around forums that have regular users. Technology, computer games and/or video games, fashion, religion, and politics are popular forum themes .(http://en.wikipedia.org/wiki/Internet_forum)
Forums are generally simple to use and are often part of social networking websites. Myspace has forums that are among the most popular on the web. (http://rankings.big-boards.com/?sort=alexa)

 MySpace
MySpace is a popular social networking website offering an interactive, user-submitted network of friends, personal profiles, blogs, groups, photos, music and videos. (http://en.wikipedia.org/wiki/Myspace). *MySpace* users can have a personal profile, upload images, video and audio files, keep a blog and participate in forums all from the one website. *MySpace* is currently the world's fifth most popular English-language website and the fifth most popular website in any language (Alexa Internet's Alexa.com's website rankings system and top 500 global websites. 2007) The local (Australian) *MySpace* was launched in August 2006.
Myspace mobile users can access *MySpace* content via mobile phone, edit their profiles as well as communicate with, and view the profiles of, other members. This is only available through certain telcos

and not yet in Australia. Although Australian users could use any browser capable phones to access the *Myspace* website, MySpace mobile is not yet available in Australia,

Photo & Video sharing websites (eg Flickr Youtube)

Photo and video sharing is the publishing or transfer of a user's digital photos or video online, thus enabling the user to share them with others (whether publicly or privately). This functionality is provided through both websites and applications that facilitate the upload and display of images and video. Most photo and video sharing sites provide multiple views (such as thumbnails, and slideshows), the ability to classify photos into albums as well as add annotations (such as captions or 'tags') and comments. (http://en.wikipedia.org/wiki/Photo_sharing)
Mobile Photo Sharing There are mobile applications available that enable the automatic transfer of photos taken with a mobile phone, to photo sharing sites, either directly or via MMS.
Youtube is an online video streaming service that allows the viewing and sharing of videos that have been uploaded by its members. Membership is free (http://www.google.com/support/youtube/bin/answer.py?answer=55749&topic=10509)
Flickr is a photo sharing website and web services suite, and an online community platform, which is generally considered an early example of a Web 2.0 application. In addition to being a popular website for users to share personal photographs, the service is widely used by bloggers as a photo repository. (http://en.wikipedia.org/wiki/Flickr)
Flickr Mobile: *Flickr* is the name of an online application to which any mobile browser provides access. Through the mobile browser, *Flickr* enables the management and sharing of digital photos or any image saved in the JPEG format. (http://help.yahoo.com/l/us/yahoo/mobile/flickr/flickr-01.html) Users can upload images directly from phones by application or email or via their mobile browser to m.flickr.com
From the above review, the scope for community-building, self-organisation and knowledge sharing through social networking is arguably broad and varied, and increasingly open to mobile access. However mobile phone access to freeware and free spaces is often made prohibitive by telecom pricing structures. At the same time, the dynamic and evolutionary form of virtual social networks is based on the capacity of these systems to be open and adaptable to changing circumstances.

DISCUSSION
A primary consideration in the design of tools and procedures for self-organising m-learning community formation is that these should be interactive, interoperable and dynamic, but more importantly, they should engage young learners in a way that encourages and supports meta cognitive development and attitudinal and behavioural change. The formative evaluation process that fed into the program design was a significant element of effective education design that is well documented in educational fields, but is a notable oversight identified in the literature on learner-driver education program outcomes (Lonero & Clinton, 2006). Participatory Design (PD) strategies used to introduce this phase to the YLDEP design – pre and post-course - generated data, the analysis of which enabled the identification of early indicators of positive behavioural change attributable to unique distinguishing features of this Community Based Education program: the active involvement of learners in the creation of learning objects (films and animations), and opportunities for participants to engage in authentic in-the-field learning experiences where they apply concepts learned in creative and active ways. Although PD is rarely considered in educational design in IBE contexts, adopting self-organisation as a principle may be the first step in empowering learners through a user-centred evolutionary approach to educational design.

Engaging participants in the capture of criterion referenced learning evidence using mobile methods and social networking tools resulted in not only richer feedback data from outdoor contexts than that able to be gathered by a researcher-observer (Isomursu, Kuutti & Vianamo, 2004), but in deeper learning through critical inquiry and reflection.

CONCLUSION

In the *Living Systems* or ecological theoretical framework applied in this case-study, 'technology' was not treated in fixed and abstract terms, as a tool or thing to be 'embedded' in the human life-world, but rather, as set of ideas circulating via feedback loops. The behavior and emergent properties of social systems supporting the familiar patterns of interaction and collective organization that characterize the voluntary and community sectors can be understood through complexity theory. In this theoretical model, social organization is characterized as a complex, multiply-interconnected network whose components are constantly changing, being transformed and replaced by other components. (Nalder, 2002). In an environment dominated by the forces of technological and structural change, organisms that survive are

those capable of co-evolution. Thus education systems must not only adapt to the new conditions wrought by wireless and mobile technologies, and their application to production, dissemination and consumption, but also co-evolve.

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UBIQUITOUS LEARNING WITH HANDHELD COMPUTERS IN SCHOOLS

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ABSTRACT
This paper provides a theoretical framework for ubiquitous learning with handheld computers with school students. It constructs a concept for ubiquitous learning and discusses learning theories associated with this type of learning. A report containing examples of learning with handhelds and ubiquitous learning in the day of the life of a thirteen year old child is presented.

Author Keywords
Handheld computers, ubiquitous learning, schools.

INTRODUCTION

Two things that characterise today's society are: (i) an abundance of information in text and multimedia formats on software packages and on the Internet, much of which is freely available and easily accessible and (ii) technology making communication and networking across long distances and shifting locations easier. In education, new handheld mobile technologies offer new ways of accessing information from anywhere and potentially also new ways of thinking and of working with others in developing new understandings and arguing for new solutions within networked communities. These technologies can include mobile phones, laptops, tablet PCs, personal digital assistants (PDAs), MP3 players and games consoles. It is also possible that increasingly more mobile learning has the potential to shape young people's thinking as a result of their connectivity through these devices (Aleven, Stahl, Schworm, Fischer & Wallace, 2003; Hargreaves, 2003, BECTA report, 2003). Consequently, the need to think in new ways and engage with others in that thinking is increasing all the time - both to respond to the new realities and also to increase their potential to enhance interactions between teachers and students.

HANDHELD COMPUTERS IN SCHOOLS

PDAs are physically mobile because of their small size and light weight. Consequently, they have the potential to be physically ubiquitous. This raises the question of whether they can also be ubiquitous learning tools. Despite their basis in business, PDAs, or handheld computers, have appealed to schools as educational tools because their small size and reduced price compared to other technologies such as laptop or tablet computers means that they have the potential to offer school children unique educational affordances through flexible access to the powers of computing. If they can do this, they have the potential to promote higher order thinking skills and to help students engage in collaborative problem solving (Kimber & Wyatt-Smith, 2006; Perry, 2003, 2006; Sharples, 2003, 2006; Waycott, Jones, & Scanlon, 2005). Some of the perceived advantages of PDAs include the potential for (i) personalised learning suited to the individual's learning path (ii) portability and access to the Internet allowing learning and data collection anywhere and anytime (iii) social interactivity where students collaborate and exchange data in both online and offline environments (iv) context sensitivity where real or simulated data can be collected in real-time working environments (v) connectivity to learning communities online, or networks of connected handhelds, data collection devices in shared learning environment and (vi) relative affordability so that they may bridge gaps between students' socio-economic backgrounds and create a more equitable social fabric. These affordances have the potential to contribute to ubiquitous computing and also to seamless learning. The ubiquitous computing approach sees handheld computing transforming educational practices in much the same way as in previous centuries the pen transformed fundamentally oral teaching practices – freeing the students from dependence on the teacher for access to information and enabling the student to take the technology with them both inside and outside the classroom (Perry, 2003). However, since handheld computers are not mini replications of laptop or desktop computers, their mobility on its own is not sufficient to guarantee ubiquitous learning.

UBIQUITOUS LEARNING WITH HANDHELDS

Ubiquitous computing and ubiquitous learning are not identical. Weiser and Brown (1996) view ubiquitous computing as 'calm technology'. When technology becomes 'calm', it does not pre-occupy the learners' attention all the time but is able to be moved seamlessly and effortlessly between the learners' periphery and centre of attention. The same idea is expressed in an apparently contradictory manner by O'Malley & Fraser (2006:12), who describe technology associated with ubiquitous computing as 'tangible' in which '*the technology is so embedded in the world that it 'disappears*". Once the computing becomes ubiquitous, it begins to have the capacity to support ubiquitous learning. Price, Rogers, Scaife,

Stanton and Neale (2003) assert that tangible-mediated learning could allow for learners to combine and re-combine familiar knowledge in new, unfamiliar ways - promoting creativity and higher order thinking. Handhelds have the potential to support seamless (ubiquitous) learning. Their small size and light weight mean that they can be easily slipped into pockets or handbags and be carried around both within and outside the school. The devices are not as powerful as laptops but the technology is evolving quickly as more software applications are produced. The Handango website listed 358 applications for Pocket PCs in June, 2007 while at the same time 2,262 were listed for the Palm platform. For the moment, the affordability of the devices means that the technology is within the reach of a wider range of students than other similar technologies such as tablet PCs. If they are able to be used, they offer a range of advantages. In schools, the availability of handhelds could alleviate the necessity to book computer laboratories or queuing to get access to technology resources such as the Internet and other reference and learning materials. The inclusion of wireless technology enables the handhelds to access information on the Web anytime from anywhere within range of the base station while reference materials such as e-books, encyclopaedia, simulations and worksheets could be installed in the handhelds allowing for independent learning anywhere the handheld was transported to.

However, because handheld computers are not powerful enough to make use of the full range of software applications, they cannot function independent of other learning or technological tools. Ubiquitous learning with handhelds is blended learning. It requires multiple technologies. Nevertheless, because of their mobility, handhelds can also be used in interactions with a wide variety of partners and in a wide variety of contexts so that learning can take place both formally and informally. These kinds of uses require sustained links between the student and the handheld, which means that these forms of blended learning begin with a personal ownership of the equipment. Effective and sustained learning also requires that handheld computers should be used to do things that other technologies cannot do (easily). In a recent study conducted by the authors that investigated the adoption of and learning with handhelds in three primary and two secondary schools, teachers were aware that more challenging tasks have to be designed for the students after the familiarisation stage of handheld usage.

> *You start from bottom, use it for a purpose not for the sake of using it…money spent does not drive it to work. It has to come from the classroom and kids' needs.* (staff#19) (Authors, Nicholas & Ng, manuscript in preparation)

But when the handheld is another piece of equipment in the school that is not readily accessible, for example, when students can access it for only an hour or two a week, there is a tendency for teachers to feel that the students have to get maximum value out of the handheld when they are taken to the computer room to use the equipment. Therefore they make a more 'forced' use of the equipment rather than to go to their espoused principle of a natural embedding in the curriculum. The result is that forced efforts are made to design curriculum around the handheld, that is *what can the students do with the handheld for this session* (focus on the equipment)*, rather than *how can the students use the handheld for learning in real time* (focus on student).

These contextual and other financial issues work against the principles of 'calm' or 'tangible' technology since they create a focus on the technology itself – even if the only issue is 'when' and 'how' the technology can be made available. Consequently, the more opportunity students have to hold the handhelds, the better will be the result of the blending of students' general learning with learning with the handheld in natural and powerful ways. As one teacher said: "students will be more connected if the pocket PC is personal" – meaning something that they could carry around with them and use in ways that they determined to be appropriate. Students having access to their own handhelds all the time enables the handhelds to be blended in as a part of their education so that the students can find different ways of using them – concept-mapping, organisation, note-taking, writing, researching, reading e-documents, doing worksheets and submitting them for checking, watching animations and movies, drawing graphs, calculating mathematical problems, data collecting, doing their homework, keeping a reflective log, undertaking recording (voice and stylus) and interacting with simulations and multimedia educational materials. Having access to a handheld all the time is like having all in one access to the pens, text books or other written resources, cameras, calculators, voice recorders, clocks and Internet. It is also within the capacity of the handhelds for email access to be made available anytime and anywhere but this use requires more investment on the part of the school to have the appropriate infrastructure installed. If all of these options are realised, the handheld becomes a natural and immersed part of the students' learning. It is this suite of technological and pedagogical arrangements that creates ubiquitous computing with the possibility of 'seamless' learning mentioned above.

EDUCATIONAL THEORIES SUPPORTING UBIQUITOUS LEARNING WITH HANDHELDS
The personalization of the handheld means that the learner is an active participant in the construction of knowledge (Piaget, 1955, 1972) and that existing knowledge and a socially interactive environment are built into the learning experience as factors that affect the construction of knowledge (Vygotsky 1962, 1978). Personalisation of the handheld also contributes to the creation of situated learning (Lave & Wenger, 1991) focusing on learning by doing and learning in context.
In the figure below, Ng & Gunstone (2002) have demonstrated how computer-based technology supports a constructivist approach to science learning.

Figure 1. Constructivism and Technology
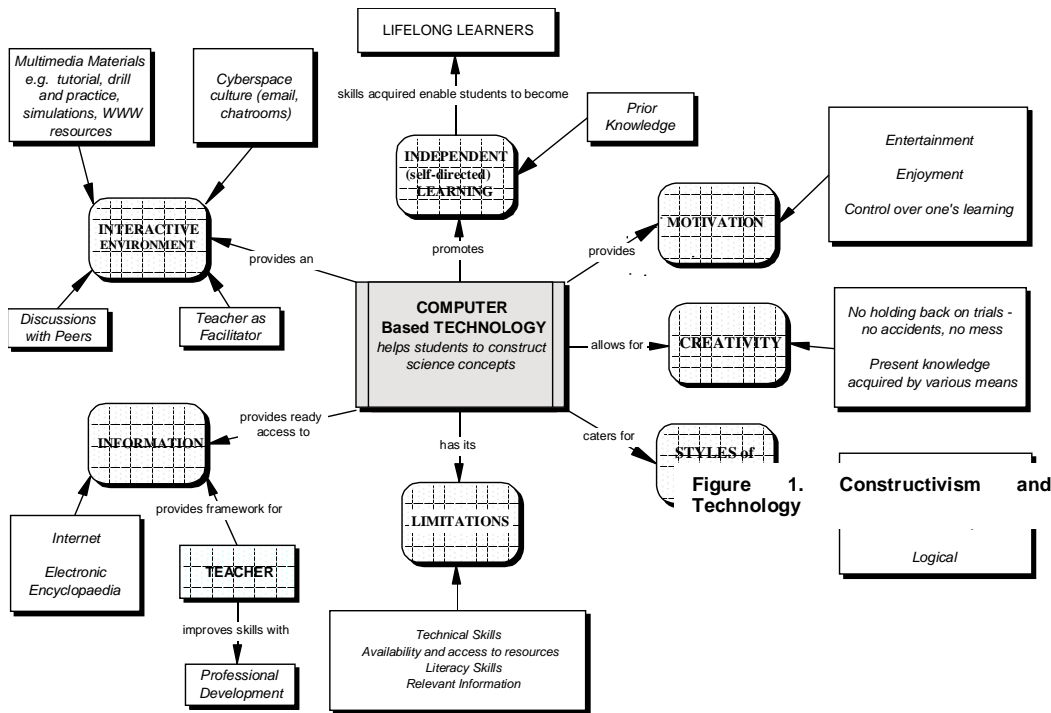
Together with situated learning, handheld technology fits well into this scheme in being able to provide a portable, interactive learning environment capable of multimedia functions and Internet access and enabling self-directed, independent learning for learners. It should be able to foster active and creative learning as it is capable of creating opportunities for students to collaborate with peers in project work (Bluetooth, beaming), to undertake independent researching (wireless) and be engaged in problem solving in real-life contexts. Its portability allows for context-based data collection and 'just-in-time' learning. In these regards, handheld technology has the potential to support ubiquitous learning where learning anytime and anywhere becomes possible. However, in order for this potential to be realized, the place of handheld computers in learning must be appropriately theorized. The mere presence of handheld computers in the school is not sufficient to promote seamless learning.

Soloway, Norris, Blumenfeld, Fishman, Krajick & Marx (2001) articulated similar thinking in the capacity of handheld devices to bring new experiences to the learning processes of students. They argued that if computers are not 'ready-at-hand' and readily available to students, they will have little impact on the students' learning because they will not be used routinely and in a 'day-in, day-out' manner.

Sharples, Taylor and Vavoula (forthcoming) have proposed a model of learning for the mobile age, using the Activity Theory to highlight the mediating role of 'technological tools', In considering the multiple technological tools that can be used in a mobile life, they have highlighted mobility over learning and the physical ubiquity of the technology without adequate consideration of the conditions for seamless learning, Our argument is that at least in the mainstream school education context, seamless learning requires planned interactions between mobile and stable technologies. Frameworks that do not acknowledge the necessity of planned and systematic interactions between mobile and non-mobile technologies (for instance, interactive whiteboards to support group work and simultaneous shared thinking) will continue to underestimate the nature and challenges of seamless learning.

UBIQUITOUS LEARNING A DAY IN THE LIFE OF A POCKET PC WITH A YEAR 8 STUDENTS
To demonstrate ubiquitous learning, a scenario is created below for a thirteen year old student where learning is visible with technology that is invisible and embedded within the learning (Weiser & Brown, 1996). The use of the handheld in this scenario is based on practical experiences gathered in the course of our research. The pocket PC that the student, Chris, holds has camera and video/audio recording functions and is able to access the Internet.

Time of day	Activity
7 am	Pocket PC alarm rings. Chris wakes up
7.45 am	Breakfast.
	After breakfast, Chris accesses Internet and logs into school website. She downloads the school days' news and announcements.
	Chris checks her pocket PC's calender and 'tasks to do' to ensure that she takes with her things needed for the day.
8.20 am	Chris leaves home to catch bus to school.
	In bus, Chris reads the day's announcements and events. She reads through an assignment that has to be submitted today, worth 50% of total mark for the subject. She makes minor corrections and saves the file.
9 am	School starts. Assembly.
9.10 am (Period 1)	English lesson. Chris downloads e-reading from teacher's laptop. Teacher provides guidelines and questions for reading and takes students to school yard to spread out and read. Chris keeps a vocabulary list in Word mobile and refers to Lexitionary (a dictionary for PDA) for meanings. She jots main points of reading in notepad by scribbling (handwriting) and to expand on the points, voice records oral explanations.
	Discussion time, when Chris iss asked one of the questions, she plays back her recorded explanations.
10 am (Period 2)	Physical Education. All the students in the class work in pairs to keep a weekly record of their individual fitness for the ten-week term. Chris works with her partner, Alex. She uses the stopwatch in her pocket PC to time how fast Alex runs two laps around the field. She also times how many push ups Alex can do in a minute. After each activity, Alex counts his pulse while Chris times the counting for a minute. All the data is entered into Alex's pocket PC. Chris takes a short video with the pocket PC of Alex doing push-up after finishing with the timing so that she can put it in her assignment. They swap roles to collect Chris' data.
	This is the last lesson where the data needs to be collected. The tasks that each group of student needs to undertake after this are to:
	• graph their own performances for each of the activities stated above. A display of the time taken to run and do push-ups and pulse rates for each activity has to be submitted to the teacher (how they do this has to be negotiated).
	• collect the class' data on pulse rates for the running activity and analyse it for averge class performance and differences between males and females.
	The class works out a systematic way of transferring and receiving the data through beaming or bluetooth functions. Chris spends the rest of the class time collecting the data and working on her analysis using Excel mobile spreadsheet. The rest of the analysis will be done as homework.
10.50 am	Recess.
11.20 am Periods 3 & 4	Science (double period). Students are studying the circulatory system. The teacher uses the interactive whiteboard to teach using Flash animations to show how the heart pumps. She accesses the Internet to show a video of a 'hole-in-heart' case. She checks the students' homework by getting 3 students to beam and display their files on the interactive white board. She gets 3 students up to the board to mark the homework which is 10 fill-in-the –blanks questions. Chris checks and

marks her own work in the handheld.

Schools in Victoria embrace the Victorian Essential Learning Standards where integrating the curriculum is encouraged. The science teacher relates the students' physical education activities to the heart. He gets the students to use their own data to calculate how much blood the heart pumps in a minute, and to use the volume calculated to work out how many 2 litre lemon squash soft drink bottles the amount that is pumped for one student will fill. The students use the calculator function of their pocket PCs to do this and record the result in notepad.

The science teacher shows the students an alternate way of graphing pulse through data logging by using the pulse probe. Students work in groups of three and conduct the activity, which enables them to see and compare all three pulse rates at once.

Lunch 1-1.50 pm	After eating, Chris and her friends show each other what they have downloaded into their pocket PCs the night before in relation to their favourite singers and gossip articles about them. Chris plays a piece of new music she has found from her favourite singer. The conversation goes in all directions. Jackie has downloaded a podcast which she thought was weird and interesting and shares it with her friends. On the other side of the schoolyard, a few boys are playing games on their handhelds.
1.50-2.40 pm	Mathematics lesson. Students are learning shapes and calculating areas and volumes of various shapes in their (paper-based) work book. For the first half of the lesson, students do some drill exercises. Chris uses the calculator to help with calculations. For the second half of the lesson, the students continue working on their team project to design the best shape for the canopy of a parachute to land an egg safely given $200 to purchase things (e.g. newspaper, string, balloons, straws, etc) to make the parachute. Chris bluetooths the things she wishes to purchase, the costs of the items calculated in Excel mobile, to her team members. All members look at the items and costing and discuss the feasibility of the items. The collaborative work and discussion continues until the end of the lesson.
2.40-3.30 pm	LOTE (Chinese) lesson. Today's lesson is focused on pronunciation of connected speech. The teacher has recorded herself reading a passage of some 10 sentences which she bluetooths to selected students. The students in turn bluetooth to their friends, speeding up the file transfer process. Students use their earphone to listen to the reading and read along at the same time. They make annotations in their books over the words that are new to help them read the passage later. They then voice record their own reading and when they are ready, play it to the teacher. Chris who was one of the first to finish with the reading exercise, opens up the Chinese writing software to practise her stroke writing of Chinese characters.
3.45	Catches bus to go home. She listens to music that has been downloaded into her pocket PC in the bus. She sees an interesting shape during the short walk home and takes a picture of it with her pocket PC camera. She will show it to her classmates tomorrow.
6 pm	Chris take out the physical education data and starts working on it. She decides that it is easier to work on the home desktop in analyzing the data and writing a discussion for the data. She downloads the file from her pocket PC to her desktop. She decides to present her analysis and conclusion in Powerpoint. She puts a hyperlink in the Powerpoint to show the video of Alex doing push-ups. When she has finished, she synchs the finished file into her pocket PC ready for school next day.
8 pm	After dinner, she finishes with her homework. She writes a few remember–to-do things for the next day.

CONCLUSION

The use of mobile technology in schools is about generational changes in pedagogy. Using widely accepted terminology, the current primary and secondary students in schools belong to Generations Y (Yr7 – Yr10) and W (Prep – Yr6). These generation of students are characterized as consumers who are also products of the online world and who are 'technologically-tuned' and keen to explore new innovations such as SMS, ring tones and mobile phone icons. To these students, the Internet and mobile devices are an integral part of their world. While a large percentage of school students, particularly adolescents, have mobile phones, their educational use is currently limited. Handheld computers on the other hand have the advantages of mobility and capabilities to do many of the things computers are capable of doing. These devices offer the potential for ubiquitous learning in ways that are independent and self-paced for the learners, providing that there is thoughtful planning to support both personalization of the mobile devices and sustained interactions between mobile and stable technologies.

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The activity is individual but the learning is social, since it is within the social interaction where the learning is produced (Vygotsky, 1978). Once each group member has constructed his/her word, they collaborate with the rest of the group.

COMPARATIVE STUDY OF PEER LEARNING MEDIATED BY INTERCONNECTED PCS AND PDAS

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ABSTRACT
The aim of this paper is to compare peer learning between a group of children working with PCs and Pockets PCs, respectively, regarding the amount of collaboration and its effectiveness. For the given implemented application, we observed that children interacted more with Pocket PCs than with PCs. However, with Pocket PCs there was more interaction than understanding, making some times useless the effortless interaction achieved by the closeness these machines allowed. We conclude that making students work collaboratively not necessarily improves group achievement. The challenge is to achieve the adequate learning environments that develops the students' interaction skills and promotes collaborative problem solving.

Author Keywords
Peer learning, Comparative study PCs and Pocket PCs, Interconnected Pocket PCs

INTRODUCTION
Already at the beginning of the 20th century, a discussion began in social psychology on the effect that social interaction has on individuals in their learning (Slavin, 1996, Vygotsky, 1978). Research appeared as the one in Collaborative Learning (CL) (Cohen, 1994, Davidson et al, 1992). In CL, group members' work together to achieve a common goal, existing consensus that the collaborative work carried out in small groups is an effective tool for academic and social achievements of the students (Zurita et al 2004).

A step further is Computer Supported Collaborative Learning (CSCL), which supports the construction of a dialogue between the members of a group and their decisions (Zurita et al 2004). Its limitations, however, are in peer learning where students are forced to work facing a screen, limiting the face-to-face experience (Zurita et al 2005). These problems can be solved using portable devices, as Personal Digital Assistants, PDAs (Danesh et al, 2001, Mandryk et al 2001, Zurita et al 2004). Every participant of the peer learning experience has the physical control of the PDA, which favors the synchronization and interaction in the group work (Imielinsky et al 2004).

The quality of the engagement that is fostered in peer learning depends of the existence of a supportive communication and assistance. This improves metacognitive awareness and regulation since there is a reciprocal process of exploring each other's reasoning and viewpoints in order to construct a shared understanding of the task. This reciprocal process of exploring each other's reasoning and viewpoints for producing mutually acceptable solutions and interpretations requires students to propose and defend their own ideas, and to ask their peers to clarify and justify any ideas they do not understand (Kruger, 1993). The aim of this paper is to compare peer learning between a group of children working with PCs and Pockets PCs, respectively, regarding the amount of collaboration and its effectiveness.
Chapter 2 presents the activity used in this experience; then, Chapter 3, the experimental study carried out. In Chapter 4, the results that threw the study are shown, and finally the obtained conclusions, Chapter 5, are presented.

ACTIVITY DESCRIPTION
The chosen collaborative activity is a game for word construction, by presenting images, for 7 to 8 years old children. While the PCs activity is performed with side-by-side machines connected through a regular network, the Pocket PCs activity is done with PDAs wirelessly interconnected.

Groups were formed by three students each (Dillenbourg 1999). The different group members had to construct a word, represented by an image displayed on the machines' screen and letters received from the child's or group mate's device. The activity assignment therefore combines an individual and a collaborative task. The individual task is that each child constructs the word that appears in his/her screen. The collaborative task is that a child sends to a group mate letters that are useful to the comrade and are not used by him. Once the group finishes the assigned words, they receive a new set of images. The aim of the activity is to foster collaboration while they learn to write words. Therefore, the feedback, right numbers of constructed words, is common to the group to encourage group collaboration.

On each students' screen appears an image of the word to construct, the pictures of the other two group members, an image of a trash can, a letter of the alphabet and a place where the word is built, Figure 1. The child had to decide if the letter in his screen is useful for constructing the word; if it s/he places the letter on the image, Figure 1b; if it is rejected s/he throws it to the trash can, Figure 1c. Alternatively, /she could send the letter to one of his/her group mates, placing the letter on the corresponding photo, Figure 1d. When a letter is received form a group mate, it appears above the picture of the child that sent it, Figure 1e. If the child wants to use that letter, s/he drags it to the image; otherwise, it is placed on the trashcan. Only once the letters' action is complete, used or trashed, a new letter appeared on the screen.

To foster collaboration, the scoring criteria is one point when an own letter is used, and double the points when a friend ones is used. When using incorrectly a letter, a point is deduced, independent from where the letter came.

Figure 1a

Figure 1b

Figure 1c
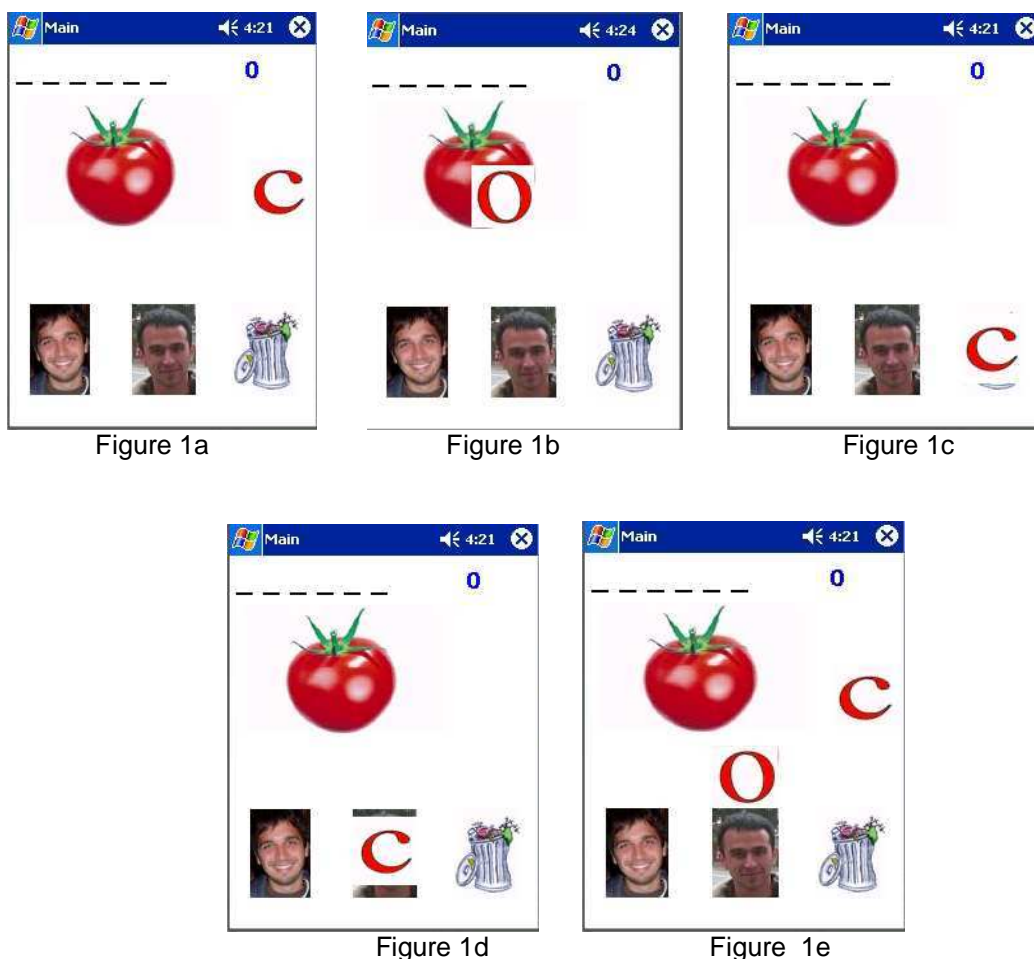
Figure 1d

Figure 1e

Figure 1: Sequence of an activity

EXPERIMENTAL DESIGN
Two experimental groups were randomly formed selecting students from the three available 2nd grade classrooms. The activity was carried out with 33 students working with PCs and 40 students working with PDAs (Pocket PCs). Each student remained with the same type of technology during the whole experience, consisting of four sessions of 45 minutes each, during 3 weeks.

In the first session an individual paper test was performed to asses the students recognition of words. A set of twelve images had to be paired with 24 words, 12 of them distracters; all words were part of those to be used in the computer based collaborative activity. The test showed that the totality of the students

recognized the words to which they would be exposed in the later activity. Additionally in this first session, the students learned how to play with game.

In sessions 2, 3, and 4, the students worked in groups of three with PCs or Pocket PCs, depending to which technology they were assigned. The groups of three were randomly assigned, considering that this has shown to be a good grouping criterion (Zurita et al 2005). They worked with their group mates for around 25 minutes. Each child action was recorded in the group's log stored in a database. The gathered information was the following one, Figure 2:
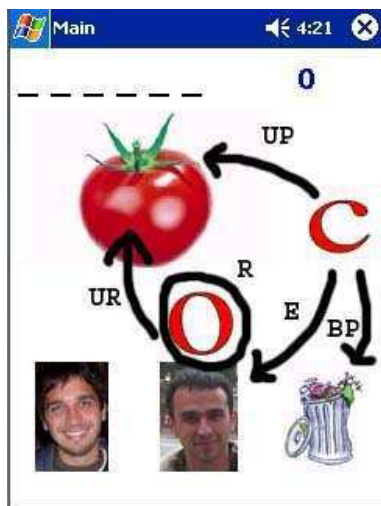
Figure 2: Actions of the activity

M   Moves: The total number of actions performed by the student.
R   Received letters: The number of letters a student received from his/her group mates. These could be useful (RUT) or useless to form the word.
E   Sent letters: The number of letters a student sent to his/her group mates.
UR   Use of received letters: The number of times a received letter from a group mate was used to form the word. These can be a correct (UCR), or incorrect use depending if the letter corresponded to the word.
UP   Use of own letters: The number of times an own letter was used to form the word. These can be a correct (UCP) or incorrect use, depending if the letter corresponded to the word.
BP   Own discarded letters: Letters of its own that were not used..

RESULTS

Considering the number of students, not all the groups worked simultaneously. Although the sessions lasted all around the same time, not all of them were exactly the same, therefore, no absolute variables were analyzed but ratios between variables eliminating the influence of the variances in effective playing time.

A first set of ratios was defined for analyzing collaboration:

E / (BP+E)   The percentage of the letters sent by a student to a group mate, regarding the total of letters not used by him/herself.
R / (R+UP+BP+E)   The percentage of letters received by a student, regarding the total numbers of letters he view in his screen during the experience.
UR / (UP+UR)   The percentage of received letters the student used regarding the total number of used letters.

	Ratio	PC		PocketPC		Significance	Size effect	Effect
		mean	variance	mean	variance			
1	E/(BP+E)	0,09	0,0311	0,16	0,0306	0,07	0,75	Large
2	R/(R+UP+BP+E)	0,06	0,0044	0,10	0,0101	0,04	0,93	Large
3	UR/(UP+UR)	0,06	0,0016	0,10	0,0034	0,01	0,99	Large

Table 1: Collaboration measurements

Table 1 shows the results obtained for the previously defined ratios. The students that used the **PDAs sent more letters**, they did not use, to their group mates, (1 in Table 1), and **received (significantly) more letters** from their group mates, from the total letters exposed to, than the students with the PCs, (2 in Table 1). Finally, (3 in Table 1), we observe that the students with the **PDAs used (significantly) more the received letters** than the one with PCs.

A second set of ratios was defined for analyzing effectiveness:
RUT / R   The ratio of useful received letters regarding the total number of received letters.
UCR / UR   The effectiveness ratio of used received letters.
UCP / UP   The effectiveness ratio of used own letters.

	Ratio	PC		PocketPC		Significance	Size effect	Effect
		mean	variance	mean	variance			
1	RUT/R	0,70	0,0476	0,58	0,0553	0,025	0,77	Large
2	UCR/UR	0,87	0,0252	0,85	0,0278	0,32	0,38	Small
3	UCP/UP	0,94	0,0014	0,90	0,0044	0,01	0,99	Large

Table 2: Effectiveness measurements

Table 2 shows the results for the effectiveness measurements. In its first result, the group that worked with **PCs had a significant difference in the ratios that measures the usefulness of the received letters**. In the second one we observe that there is **almost no difference in the effectiveness of the received letters**, while in the last one we observe a **significant difference towards the PC in the usage of own letters**.

CONCLUSIONS

To achieve understanding, group mates should explain each other their ideas, verbalizing their understanding, making explicit the difference in what is in their minds and their utterance, and by doing so obtain a clearer perspective of the topic (Gillies 2006). From Table 1 we observe that children working with Pocket PCs sent more letters they did not use for themselves to one of their classmates, than the ones that worked with PCs. This indicates that children interacted more with Pocket PCs than with PCs favored by the close distance between them, Figure 3a .These interactions were fast with minimum verbal expression, and by the fact that each group was competing with the ones close to them, even this was not a defined and explicit objective. On the contrary, with PCs it could be observed, Figure 3b, that the children had difficulties relating to each other, sometimes even having to stand up and walk to reach a group mate. We can conclude from Table 2 and Figure 3b, that with Pocket PCs there was more interaction than understanding, making some times useless the effortless interaction achieved by the closeness these machines allowed. On the other hand, the distance barrier between children and the sight blocking of the PC screen slowed PC working children contact down, favoring understanding.

Even Pocket PCs favored the interaction of the students, in an assignment that combined a collaborative and an individual task, the excessive interactions had a negative impact in the performance. Making students work collaboratively not necessarily improves group achievement. The tasks chosen for peer collaboration have to be structured so that children must work together cooperatively for joint action and task oriented verbal explanations (Fawcett and Garton, 2005). Therefore the internalization of an answer has to be a jointly elaborated process of the different actors (Pata, Sarapuu, Lehtinen, 2005) where the quality and adequacy of the joint process is a key issue.

(a) Collaboration with Pocket PCs   (b) Collaboration with PCs

Figure 3

      From Table 1 we can also conclude that in both platforms the children preferred to use their own letters. We have not really achieved in this activity the aim of CSCL whose focus is not so much on the individual who learns and thinks, as it is the collaborative group that explores and reasons (Crook 1994; Dillenbourg 1999). Not every activity fosters collaboration. Depending on the task, sometimes individual work is more adequate and will show better results than collaboration. As (Shar, Shachar, & Levine, 1999) indicate, the difficulty is to achieve the adequate learning environments that develop the students' interaction skills and promote collaborative problem solving.

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THINKING ABOUT THE 'M-' IN MOBILE LEARNING
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Contemporary environments of learning
There is, in educational contexts, a justified intensity of interest around the effects of digital, in particular portable technologies in all manner of ways. There is a promise of greater 'reach', of more and easier access, of a kind of democratization of education, a sense not just of a transformation, but a revolution of wide- and far-reaching areas of the educational world. The emergence of these technologies is accompanied by economic, political and social changes, which are related and connected everywhere, and, if anything, more profound in their effects; this heightens both the effects and the expectations. At the same time, social, political and economic changes are coming together with pedagogic changes at a breathtaking pace, and so it is, maybe, little wonder that the responses are equally breathless.

The social, political and economic effects are often gathered under the banner of 'globalization'; they are multiple, often contradictory or at least in tension with each other, difficult to untangle, and seemingly impossible to control. In this paper we want to show some of their effects on and in education in order to set the ground for a discussion around technologies and education. In any one locality – and for the purposes of our discussion here – we might say that together they amount to a transfer of power from state to market, so much so that in some places – the UK being one such – the state seems to have the role of being that of servant of the market. State and market once had quite different aims and goals, and as far as the education 'system' was concerned profoundly different effects therefore. The (19th century) nation-state, in Europe at least, needed the education system to produce 'citizens' for the purposes of the state and a labour-force for the national economy. We will not attempt to sketch the meanings and values promulgated in such education systems, nor their effects; suffice it to say that they aimed at a kind of homogeneity through the notion of the citizen, and in many ways similar to the values held as essential for the labour-force.

The market differs profoundly in both respects; it has no interest in the production of a labour-force: it needs consumers; and where the state wanted – for its reasons – a high degree of homogeneity, the market in its contemporary form is interested in a high degree of differentiation. These differences have profound effects for education. Our case here is that any assessment of the effects of technologies on education have to be set in this frame, for they set the foundations of the environments of education in which technologies can become active, and in which their use is shaped. With the market as the ruling, dominant social model, identity is shaped through consumption, rather than through the achievement of a place in a social structure and a place in the labour-force. Agency is exercised as choice from commodities provided by the market. These factors become naturalized as the ruling social model and, once naturalized, become the dominant effects and forces in education, itself now experienced and lived in terms of the market.

In an educational context, the model of choice in the market makes learners into consumers, and all that pertains to the structures and experiences of consumption now becomes a feature of educational processes. The move from teaching to learning, from the authority of the teacher to the agency of the learner, is the effect of the naturalization of the market model in the domain of education. Teachers held scarce resources, and had the authority to dispense them. The contemporary form of the market does not know scarcity, whatever the commodity; rather it poses the problem of choice. In marketized education *learning* is *consumption*. Now all the emphasis is on the agency that attaches to choice, on the agency of the learner as consumer rather than the authority of the teacher.

In this context, digital technologies hold out the promise of unlimited access to educational commodities and of the consumer-learner's sovereignty of choice. But of course, the perspective of the learner / chooser is not the only one. The state as the servant of the market is highly interested in speeding a development which seems to hold the promise of significant saving in resources. That phenomenon, too, is not limited to education: in all social domains, the neo-liberal state attempts to reduce its commitments: whether in social services, pensions, health, whatever, increasingly the requirement on individuals is that they should assume responsibility for their own affairs.

In other words, the centrality of 'learning' is everywhere entrenched as a part of contemporary social/political trends; the digital technologies offer the seemingly best chance to achieve much of this

in the domain of education. Our paper attempts to examine what actually is entailed in this, as an advance or a benefit; or what might be surface, glass beads offered to the natives, glitter without substance. We take the case of mobile-learning as our example, though we believe that it can stand in for many, most or maybe all others.

The question of affordances: characteristics and potential of digital technologies
The intensity of interest in digital technologies is also to a large extent motivated by a certain fascination, even fetishisation, of technology by parts of society, in particular policy makers. Perpetual developments in technology, coupled with its continued reduction in size, have resulted in an unabated integration of technology into social and cultural practices, for example leading to the possession of technological gadgetry as a status symbol.
In the literature this fetishisation of (digital) technology, depending on the author's point of view, is often conceptualised either as technological versus social determinism or as utopia versus dystopia.

Bruce and Hogan (1998) rightly point out that technologies should be viewed as ideological tools which embody social values and that they are organic "because they merge with our social, physical, and social beings". The question for them is one of how technologies are realized in particular settings and whether they become so embedded and integrated in our lives, discourses and activities that they become invisible. Bruce and Hogan also point out that effective use of technologies becomes the norm and a lack of an ability to use them can become a (negative) social and cultural marker. This consequence represents a particular danger of the **'disappearance' of technology** and is inherent in its increasing integration of digital artefacts in the 'ecology' of everyday life.

They conclude that it is less useful to focus on the technical attributes per se, instead there is a the need to understand the ways in which ideology is embedded within technology.

> To understand what a technology means, we must examine how it is designed, interpreted, employed, constructed, and reconstructed through value-laden daily practices. (Bruce and Hogan, 1998)

This recommendation notwithstanding, and despite some questioning of the usefulness of the notion of 'affordance' as a metaphor (Oliver, 2005), we want to examine, albeit briefly, some of the characteristics, properties, potentials and implications of digital technologies here.

Recent years have seen a growth in the social networking capability of web-based services, known as 'Semantic Web' or 'Web 2.0'. These terms refer to online collaboration tools, such as photo and video sharing services, pod- and video casting, weblogs, wikis, social bookmarking, syndication of site content etc, which facilitate the sharing of content by users. In other words, they characterise a fundamental **shift in agency** from broadcast to content generation, a decentralisation of resource provision and, as the Wikipedia entry on Web 2 dated March 23, 2007 suggests (http://en.wikipedia.org/wiki/Web_2), an enhanced organisation and categorisation of content with an emphasis on 'deeplinking'. The shift in agency is also one of user-led media content consumption, for example, with users increasingly selecting what information to access and what music and films to watch and when.

New generation digital technologies can also be characterised by a **new breed of users**. Bruns (2007, p. 3) refers to them as 'Generation C' which, according to him, is best understood as a loose grouping of participants who share a set of common aims and practices around user-led content creation communities. They 'occupy a hybrid, user-*and*-producer position which can be described usefully as that of a *produser*' which can be seen to be characterised by the following:

- Community-Based – produsage proceeds from the assumption that the community as a whole, if sufficiently large and varied, can contribute more than a closed team of producers, however qualified they may be.
- Fluid Roles – produsers participate as is appropriate to their personal skills, interests, and knowledges; this changes as the produsage project proceeds.
- Unfinished Artefacts – content artefacts in produsage projects are continually under development, and therefore always unfinished; their development follows evolutionary, iterative, palimpsestic paths.

- Common Property, Individual Merit – contributors permit (non-commercial) community use, adaptation, and further development of their intellectual property, and are rewarded by the status capital they gain through this process. (Bruns, 2007, p. 4)

In short, the characteristics of (the effective use of) new digital technologies revolve around a combination of technology- and user-related factors. They all bring with them challenges for users in general, and those in educational contexts, be they formal or informal. One such challenge, for example, surrounds the physicality of the devices: due to their small size the amount of data that can be displayed at any one time and the ease with which it can be manipulated is limited. They include:

flexibility and portability: digital technologies are characterised by their relatively small size which makes them readily portable and, therefore usable anywhere anytime. Increasingly they offer connectivity and networking. Being digital they allow resources to be easily modified, presented and re-presented according to changing needs and user groups.

multifunctionality and technical convergence: mobile devices now normally feature more than one function. Whereas only recently separate devices were needed to listen to music, look at images and watch video, maintain a calendar and contact list, view computer files created by different software packages, read e-mails, view webpages etc, these functions are now readily available at affordable prices as single small devices. This characteristic includes availability on demand as well as the creation of content 'on the fly', i.e. in real time.

multimodality: digital technologies allow content to be presented using a diverse range of systems of representation and a combination of different semiotic means of meaning-making. Digital video, for example, allows learners to create representations of themselves and the way they see and interact with the world, for example in the form of narratives or documentaries that are not based on traditional notions of textuality.

nonlinearity: hyperlinking, i.e. the ability to break up sequential ordering of information / pages / screens and allow lateral connections intra- and intertextually, between related as well as unrelated documents / artefacts, allows for unprecedented levels of interconnectedness and possible synergies.

interactivity and communicative potential: mobile devices allow for new forms of creative relations between people on the basis of reciprocity and negotiation, in writing and in speech, in real time (synchronously) or delayed (asynchronously). Exchanges can be recorded, stored and analysed post hoc; overcoming the ephemerality hitherto of spoken interactio. Communication between a number of interlocutors can occur concurrently and multi-directionally, with different conversational fragments being interwoven.

There are larger level social consequences. Digital technologies and their affordance have a significant socio-cultural impact which we want to allude to by raising some questions even if we do not provide answers to them here. In particular, the question needs asking to what extent they can, or already have, become a prosthesis for some users and what their impact is on notions of the self and society. To what extent do, can and should they govern the way in which we perceive and apperceive the world around us? What is the impact of the (seeming?) fracturing of the self into multiple identities as well as the membership of a wide range of user groups and communities of practice? How important for notions of society is the lack of shared cultural experiences as a consequence of a move away from a centrally determined broadcast contents and media of transmission and the move towards a 'distributed' culture and a model of knowledge assembly? What of the increased fragmentation of mainstream culture into scenes, and the sub-cultures of life styles, each with their own practices? Or what of the individualisation of social and cultural experiences on the basis of the principles of bricolage?

Here we mention just two such issues:

(meta)collaboration: closely related to the communicative potential of digital technologies is the capability of collaboration with others across traditional barriers of place, peer / age / interest / professional groups, social strata etc. 'Meta-collaboration', understood as effective and successful

membership of 'Generation C' (Bruns, 2007, p. 8), includes the knowledge when, where, and with whom (not) to collaborate and to understand its consequences. This, Bruns (2007, p. 7), points out, requires a critical stance both towards potential collaborators and their output as well as towards one's own abilities and work.

virtuality and hyper-reality: widely used metaphors in the discussion of ubiquitous technology are 'virtuality' and 'hyper-reality'; yet, their use is rarely problematised and their meanings seldom defined. A narrow dictionary definition of 'virtual' with reference to computing is 'not physically existing'; in the main, virtuality is normally used as a parallel reality to the physical world. In an interesting think-piece, McFarlane (2003) posits the following five 'rules' of virtuality:
• the uptake and use of new technologies depend crucially on local social contexts;
• the fears and risks associated with new technology are unevenly socially distributed;
• virtual technology supplements rather than substitutes for real activities;
• the more virtual, the more real; and
• the more global, the more local.
In short, notions of virtual realities are problematical and can't be seen as existing divorced from the here and now. The use of digital technologies does not transport oneself into another world, rather it affects the world in which we live, work, learn, shop, seek entertainment etc. Price (2007) expresses the potential of digital technologies to link to and interact with the physical world as 'augmentation'.

Beyond the surface: what *is* learning?
At the moment the list of prefixes available for the word 'learning' is a near endless one and it grows by the day: e-, m-, online-, ubiquitous-, life-long-, life-wide-, personalized-, virtual- etc. learning. The question is: why this sudden explosion of kinds of learning, what is it about? Many of the prefixes point to technology, whether as m- or as e-, as virtual- or online-. In view of the numerous characteristics discussed above, it might be good to ask whether any of these point to different *kinds* of learning? In the case of *life-wide* and *lifelong learning*, the prefix indicates sites and temporal extent; and with *ubiquitous* there seems the idea that conditions and opportunities for learning are boundless. It seems, in other words, that the issue is not a difference in *kinds* of learning but in *conditions* and *environments*.

Is this the case with the 'e- forms' also, in their various guises? Is there a difference in kind between *on-line* and *e-learning*? Or, a slightly different question: what exactly is 'virtual' about *virtual learning*? Are all these in fact descriptions of conditions and environments in which learning takes place, environments distinct enough to suggest a significant difference in the experience of learning, even if not a difference of kind?

One way to start may be to ask the simple question: 'so what *is* 'learning'? In answering, our approach is a semiotic one. That is, we see a very close connection between *meaning-making* and *learning*, in semiotic terms between the *making of signs* and the *making of concepts*. For us, both are the result of semiotic work: that is, purposive work with meaning-resources. Semiotic work produces change; change in semiotic resources produces meaning; so semiotic work produces meaning. Semiotic work changes the tools – the semiotic resources; it changes that which is worked on; and it changes the worker.

In the example just below (Figures 1 and 2), we show two three-and-a-half year old girls trying their hand at writing.
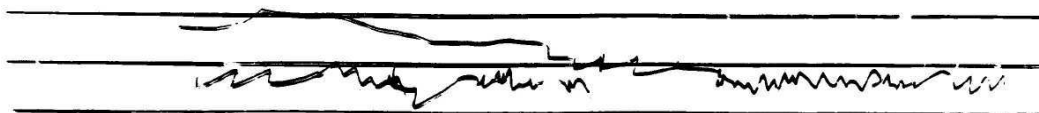
Figure 1: Alphabetic script
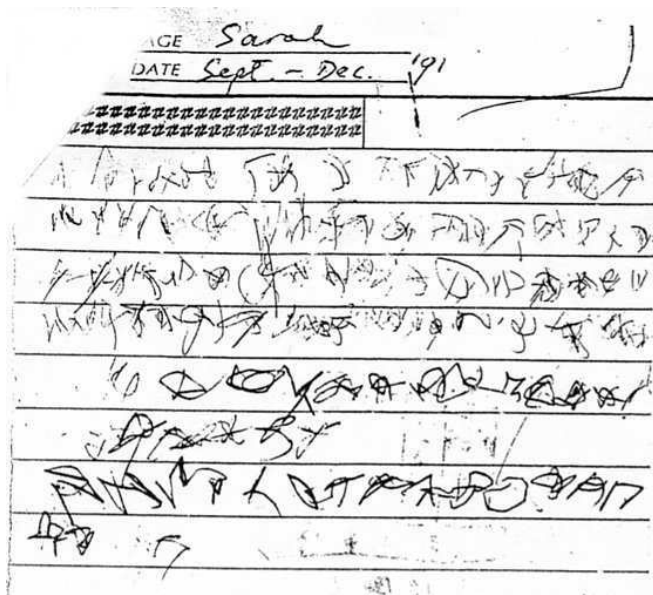
Figure 2: Character-based cript

We think that each of the two examples is the result of semiotic work. Each is the result of an engagement with a salient aspect of the cultures of the two young writers. The contrast between the two shows that their 'writing' is a principled attempt – that is, an engagement on the basis of discernible principles – to understand the bases of the script systems of their cultures. Neither is mere scribbling, or simply incompetent imitation. In the case of 1 a) (some) of the principles might be: the elements of the script system are simple; they seem at times to be repeated; they are linked; they are produced in sequence; they are displayed on a line. In the case of the other, the principles might be: the elements of the script system are complex; they are not repeated, each differs from the other; they are not linked; they are produced in sequence; they are displayed on a line.

Our assumption is that the graphic work here represents meaning, in the way we have described it; the 'inner' resources of each of the two are changed as a result of this work (the evidence for that lies in the gradual change that can be discerned from this to the next instance, over time); the semiotic / conceptual resources of each of the makers of these signs is changed. In their work they have learned something about the script system of their culture: they have changed; and the resources they have for dealing with their cultural work also have changed.

In this view learning is change; it produces both a transformation of that which was encountered and of the learner; it is an augmentation of inner (conceptual) and outer semiotic resources.

Given our focus on conditions and environments of learning, we might ask a number of further questions, such as: *whose attention* was at issue here? That is, who decided that this should be attended to? *What* has been framed? *Who* has framed the world to be engaged with? In school, traditionally, the answer would be "well, the teacher has directed the attention of the children to this phenomenon". Out of school, the answer is "the children's own *interest* directed their attention". Teachers are likely to answer the question "what has been framed?" differently to children – in one case it would be an answer to a curricular question "what has been framed is the script system of the two cultures", "learning of writing", "a question of literacy". In the other it is a question about fun, pleasure, genuine curiosity and puzzlement. Neither of the children might be aware of adult criteria: it is quite likely that both thought they were "drawing writing". In one case power is at the base of attention and framing, in the other case it is interest and pleasure. Agency in one case is that of the two three-and-a-half year olds; in the other case agency is complex and mediated, from curricular authority to teacher to children. Of course each has their own interpretation of their agency, and therefore each acts in distinct ways.

The question of "whose power is at issue?" seems one necessary starting point. It also provides a crucial point of 'completion', in the sense of evaluation and assessment. Where official power of curricular authority is at issue, the principles of evaluation will be those of that authority. Relative degrees of success or failure will be assessed / measured in terms of the criteria of that authority. If the learners' power, their own interest is the starting point, then the principles of evaluation will be those of the learner. If that which has been made/drawn/written by each of them satisfies them, then their aim has been achieved. Official pedagogy (and its deeply entrenched common-sense derivatives) might not recognize that learning has taken place here: it is unlikely to have apt principles of recognition.

Here is one crucial point of attention for a general account of learning: the frame of institutional pedagogy is neither necessary nor necessarily most efficacious for learning. Institutional pedagogy has its special and important frames and contents, and principles of recognition of learning – or at least of behaviours which might be efficient in simulating what is expected as learning. In all learning these are the central issues: whose agenda is at work, with what power, with what principles of recognition of learning? How is that agenda presented and is it accepted or recognized by those who are potential learners. As 'learning' escapes the frames of institutional pedagogy – a matter in which the e-technologies are deeply implicated – these are questions of increasing importance.

We might note, in passing, that our assessment of the children's writing had been on the basis of *their* attention, *their* framing; and that our assessment of their learning had focussed on the principles which seemed at work in their engagement with the world.

The questions of "what is to be learned", "whose framing?", "whose power?" will increasingly come to the fore. The forces of the market push in the direction of individual agency in the choice of commodities – pedagogic or other. The current trend toward "personalized learning" is of course just one further response to that. We might note, simply in passing, that some of the inherent facilities / affordances of the e- technologies entirely support and sustain and even accelerate this trend.

Contemporary environments of learning and the dilemma of the school
We might also note in passing that three questions might be useful to pose, in relation to current interests in learning: "what stays?", "what changes?" and "why?".

The dilemma for the school arises out of specific mixes of the factors we have so far mentioned. They are culture, technology, environments and (conceptions of) learning. Culture cannot be thought about other than in the presence of power, that is, in social environments. What society expects of 'its' education system of course shapes what 'the school' can and must do – at the moment at least, though that, as we pointed out is changing. If the school has had the task of putting forward certain forms of knowledge and kinds of value, as the servant of the state and its economy, then there is now a clear disjunction between school and state, state and market, and market and school. No new accommodation is as yet in sight. The state pursues policies to favour the neo-liberal market, which pushes the school beyond its control. At the same time the state attempts to use the school – as one of the remaining instruments under its control, to promulgate traditional values – relation to nationality/culture/ethnicity/ethics. The school has lost its two major supports: the unquestioned support of the state, and the promise of the reward of a (relatively) secure place in the productive economy.

All the time, digital technologies, which dominate the cultural and economic domain, urgently suggest the same potential for action as those of the market. If technologies are – in the end – culturally shaped tools to manage the world, then there is a close homology at the moment between the facilities offered by these technologies and the promises of the market. Dominant models of learning are provided by the seductive model of the freedom of the consumer in the market – unfettered up to the moment of truth at the checkout of the super-market. Yet there is also truth in the model, for those at least who are in possession of the necessary wherewithal at the checkout. The two lies of the model – one, the harsh reality of the checkout and the other, the less obtrusive reality of the near invisible limitations of the offer of commodities in the supermarket – "you may have everything you may wish for – from the things we make available to you" – do not deny or undercut agency: they simply confine it. If consumption is identity, then you may become any identity that combinations of the resources of the supermarket (of course constrained one more time by 'fashion', the naturalization of convention). And if consumption is learning then you may, as learner engage with everything available to you *here*.

What this model does not supply are 'navigational aids', that is, resources for making sense of this world of choice. What the model also does not supply is *knowledge*: it supplies 'stuff', which an individual assembles in relation to their interests. This adds another point, the final one that we wish to make at this time, to notions of learning, and environments of learning and their effects. In the not-so-distant past the school had provided a curriculum which was much more than a set of things to learn, but was a set of tools which had utility in relation to the problems encountered in the social and economic world. It provided a curriculum of knowledge and of skills – that is, of tools for dealing with problems in a known world. As the world around the school has changed, so this curriculum has lost its utility: the world to which the school could provide answers is a world with different demands.

Learning and technologies of text-making

Where before 'learning' had as one of its meanings 'the acquisition of knowledge relevant to issues encountered in the world', now the individual is asked to shape *their* knowledge out of *their* own sense of *their* world:

> Information is material which is selected by individuals to be transformed by them into knowledge to solve a problem in their life-world. (Böck, 2004)

The demand made of individuals in the market-dominated society is nothing short of that of developing a new habitus of learning. What it amounts to is constantly to see the life-world of the individual framed both as challenge and as an environment and a potential resource for learning. In the article from which we have taken the quote just above, the author speaks of a fundamental change in what she calls 'information habitus', that is, from a habitus where the individual could rely on 'authorities' of the relevant kind to bring information and knowledge to them (what she terms '*Bring-schuld*', that is, the authority had the responsibility to bring knowledge to the individual), to one in which the individual is now responsible for obtaining and shaping that knowledge for themselves (what she terms 'Hol-schuld', that is, an obligation resting with the individual to obtain information / knowledge for themselves). Her concepts are based on an extensive and detailed ethnographic account of a geographically marginal community in Upper Austria, where she found a distinct difference in terms of this habitus. Importantly, the difference was not so much one that could readily be described in larger level terms such as *class* or *generation*, rather these were *dispositional* differences which could only be tracked through micro-historical accounts of the individuals concerned.

These differences are apparent in forms of texts and in modes of text-production, themselves related to the factors so far mentioned, though also, importantly, to technologies of text-making and to technologies of (text) dissemination.

The point can best be made through examples. Figures 3 and 4 show book pages from a book first published in 1926 *The Boy Electrician* and one from 2006 (a Dorling & Kindersley book *Encyclopedia of Sciene*) respectively, that is, a change in the form and meaning of pages over a period of eighty years, in which one settled form of representation has been definitively overtaken by a new, deeply different one. It is also the period during which the social and economic changes we have been describing have been taking place.

Figure 3: The boy electrician

Figure 4: Encyclopedia of Science

There are two points that we wish to make in relation to these texts: one is around the relation of *author and reader*, and the other is around the issue of *medium and 'site of display'*. Other factors – such as the shifts over the more recent decade in use of image and writing – have a fundamental effect, though we will not discuss that here. In the first example we have a clear example of 'Bring-schuld': the author has assembled 'knowledge' about electricity, which will be interesting and above all helpful to young boys in experimenting with the kinds of things they make.

That is the author's task; the reader's task is to follow the *order* of the author's setting out of this knowledge. *Order* – as *reading path* – is designed into the text: the order of reading, from line, to syntax, to paragraph, to chapter. *Reading against* the order designed into the text is not possible, unless one has no interest in understanding the text the author produced. The issue of '*site of display*' does not seem to be an issue; though when we turn to the Dorling & Kindersley book it becomes clear that display affects content. With the book from the 1920s, it is the other way around: content determines length of chapter, as well as the distribution of images within the written text. The profound change illustrated here, in the Dorling & Kindersley text, is that of a change in *order* and in *who determines order*. Here the reading path is not firmly fixed, indeed really not fixed at all. It is the reader's interest which determines the order in which the page will be engaged with, 'read'. In effect, readers design their own ordering of the page; and to the extent that readers' interests differ, the page offers the potential of different distinct 'designs' – e.g. writing first, image second; or, large image first, smaller images second; or etc

What we have here is a transition from a stable, settled world, of knowledge produced by authority / authors, to a world of instability, flux, of knowledge produced by the individual in her or his life world, out of resources available to her or him, and in relation to both needs and interests that come from the reader's life-world.

From the perspective of 'mobility' we might say that the former world was *im*mobile – at least relatively speaking – while the present world has become highly mobile. Here *mobility* resides in respect to *who* produces knowledge and *how*. The move from *reading* to *design* is a move from a world in which the text is an authoritative source of knowledge to one in which the text is treated as a *resource*, available for the reader's production of knowledge.

From one perspective, a text had traditionally been a settled and coherent projection / account of knowledge about a framed aspect of the world, produced by the figure of the author. Contemporary forms of text, by contrast, are dynamic, fluid, and above all, *contingent*; they are ever more frequently multiply authored, with 'shared' / distributed power and consequently *provisional*. In their form they realize contemporary forms of social organization: of *distributed* resources, *distributed* information, *distributed* power, *distributed* across life-worlds organized as life-style. The new social arrangements find their realization in new genres we mentioned above: blogs, wikis, and so on. A world of stability has given way to a world of fluidity; a world of the power of the author has given way to a world of collaborative text-making; and a world of canonicity – whether of knowledge or of text – has given way to a world of provisionality.

That is the larger environment in which we think the issue of *mobility* has to be considered.

'*Mobile* learning' as an example of digital learning: hunting –isms
Our discussion so far has in part been an attempt to show that *mobility* is a feature of the contemporary social, political, economic, political and *technological* world. It is by no means a feature of the latter alone; and in our view it would lead to an entirely misleading analysis of the effects of technology to think otherwise. Younger readers of printed texts treat them as resources: they take to themselves the right to act in a highly mobile fashion in relation to them – and that applies not only to the D&K texts, but for them, to all texts. So several questions pose themselves around *mobility*: 'who is mobile?' and 'what is mobile?' If we do not see the widespread mobility everywhere, we will certainly misdiagnose mobility in relation to digital media.

In 'mobile learning' we have, first of all, individuals who have the new habitus of learning (never mind the existence of devices which had provided relative mobility for learning – in museums etc) which we have described above. A part of the development of that habitus is that those who 'have' it are accustomed to immediate access to the world (to be) framed and that it should be ubiquitously available. *Ubiquitous access* to resources for learning assumes an attitude to the world where all of the world is always already curricularized, everywhere. The habitus has made and then left the individual constantly mobile – which does not refer, necessarily, to a physical mobility at all but to a constant expectancy, a state of *contingency*, of *incompletion*, of moving toward completion, of waiting to be met and 'made full'. The answer to 'who is mobile?' is therefore 'everyone who inhabits the new habitus'. Given the new learning habitus, the answer to 'what is mobile?' is then 'all the world'. All the world has

become the curriculum; the world itself has become curricularized. The habitus of the individual for whom all the world is always already seen as a curriculum, becomes shaped by that experience and expectation: always expecting and ready to be a 'learner'.

The development of devices for 'mobile learning' rely on the existence of a habitus of mobility, provisionality, fluidity, etc. That which is 'mobile' is *not* knowledge or information, but is the individual's habitus: whether I am out in the country-side, in my bed, or in a classroom is, relatively speaking, beside the point. What is NOT beside the point is the ability to bring things into conjunction which might previously have been relatively difficult to join. An instance of this might be data-logging. I take a device with me somewhere. On the device forms of information can be recorded (or it may be (pre-) specialized to the recording / coding of information). I record the information in the manner enabled by the device. The site where I have gone has been turned from 'a field' or 'a meadow' into a science classroom. I have taken my (budding) habitus as scientist into the field together with a device that conveniently enables me to 'log' information. When I left the school to go to the meadow or when I return to school, say, I have in fact not left a site of learning: I have turned the environment in which I am, whatever it may be and wherever I may be, into a site of learning

We might leave the issue there, except for one thing: to return briefly to the questions of attention, framing, engagement and of assessment. While in principle all the world may be becoming curricularized, the environments of learning will still vary from time to time, depending on the individual, their position, etc. And so the environments of / for learning will vary: from those where power is still exercised in traditional ways to those where the learner has power to decide (and the responsibility for the effect of the decision); where framings of the world are determined by others or by oneself; curricula set by others for their purposes, and forms of assessment determined by the power of others or by the individual. For the time being, there will be a 'mixed economy' of pedagogy and learning.

A few (and troubling) questions
Given the wider and dominant social conditions, digital technologies have the potential to place me, as learner, at the centre of the world. One might ask 'what gain?' and equally one might ask 'what loss?' In the societies which we have known, and which seem to be involved in a relentless process of deconstruction, a common curriculum provided one major resource for community – in part what we have described as the educational project of the nation state. When all those who attended school had access to the same knowledge then even those who rejected it in any one of many different ways had been through a process of engagement and rejection: the curriculum had provided a common agenda of knowledge, values, skills, dispositions: the essential resources of 'community'. Personalized learning, with a personalized curriculum, can, in that context be seen as the end-point of the neo-liberal project of the destruction of community. Of course it can also be seen as the triumph of individuality. The question is: 'what place for community?'

We might also ask about the effect on individual habitus of a curricularized world, a world seen in terms of occasions and resources for learning. Where are the sites of difference, from where entirely different perspectives open up? Where are the opportunities for (seeming) down-time? And where are the times for reflection? In the world of insistently urgent choice of a pedagogic market, where is the time to opt out? In a period of increasing speed where is the time for slowness?

We might, in that context, wish to argue for a concern with rhythm, an alternation of pace, the slow and the speeded up, and each for its purpose. We definitely need to ask whether the task for us is that of adaptation of ourselves to technologies (including the social technologies we described earlier) or whether the urgent task is a careful consideration of the utility in a wide range of ways of our adoption of technologies for considered purposes. In the period of speed, we might wish to make a plea in praise of slowness.

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NETWORK AWARE EFFICIENT RESOURCE ALLOCATION FOR MOBILE-LEARNING VIDEO SYSTEMS

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ABSTRACT

A serious bottleneck in mobile learning is the non-availability and variations of sufficient bandwidth required for multimedia applications. Mobile systems have currently been researched for learning applications. While much research has been done on multimedia compression and network resource optimization, multimedia delivery remains a big concern. In this paper we deal with the issue of intelligent transmission of video sequence over the mobile network. We also ensure network adaptive content delivery to the user making our system attractive for real time applications. We incorporate the knowledge of the network conditions to determine how various parts of the video frames are encoded. An estimate of the available network bandwidth is then obtained which is distributed optimally between the different frame constituents based on their relative importance and motion by the bandwidth allocation module. This approach helps to reach an efficient trade off between perceptual quality of the video and the available network bandwidth. While this scheme is robust and operational for all low motion videos with identifiable visual objects, we take the example of educational videos to demonstrate the proposed scheme. This approach promises great improvement in mobile learning experience of the users.

Author Keywords
Bandwidth allocation, mobile learning, video coding, video classification

INTRODUCTION

E-learning and streaming media has immense potential of development over mobile devices. Smith et.al. 2005 studies the usage of wireless networks for e-learning. Various developed countries have reserved a big proportion of education funds to support e-learning to enhance the educational exports. Mobile devices play a crucial role in this spread of education. Strazzo et. Al. 2001, Lee et.al 2003 discuss the potential and increasing popularity of e-learning. However, a serious bottleneck towards mobile multimedia learning is the non-availability of required bandwidth to view the lecture videos at good resolution because of their large size. Other challenges in video streaming are the dynamic change of bandwidth (as in wireless and dial-up networks), packet loss, and the differences of video content and users' preferences. Although a lot of work has been done on content-based classification, content-based streaming, bandwidth adaptation and on network issues, a complete framework that addresses all these issues to provide an end-to-end solution for e-learning videos does not exist. Meeting bandwidth requirements and maintaining acceptable image quality simultaneously is a challenge.

General video coding standards and formats like MPEG-1, MPEG-2, and H.261 etc. achieve a high rate of video compression but educational videos are not separately dealt by these standards. Continuous rate scalable applications can prove valuable in scenarios where the channel is unable to provide a constant bandwidth to the application. Such decoders are particularly attractive because of their flexibility in allowing only one image or sequence to be stored in the database, avoiding the overhead of maintaining several coded images or sequences at different data rates. A specific coding strategy proposed by Shapiro et. Al. 1993 and researched by Delp et.al. 1999, known as color embedded zerotree coding is well suited for continuous rate scalable applications. This coding scheme generates a bitstream such that the reconstructed image quality progressively improves as more and more symbols from the encoded stream are used for decoding.

The proposed approach applicable to all low motion videos is exploited and explained in this paper for educational videos. The rest of the paper is organized as follows. Section2 presents a brief literature review. Section 3 gives a brief overview of our approach. Section 4 briefly outlines the classification and segmentation process for classroom lectures. Section 5 outlines the compression scheme. Section 6 explains the bandwidth allocation to the different VOs. Experimentation and results are shown in section 7 followed by conclusion in section 8.
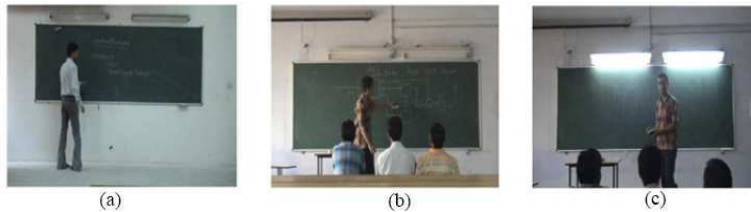
Figure 7. Snapshots of classroom Lecture sessions

2. RELATED WORK

Several organizations are providing curriculum based video and web courses. These online courses are an alternative to classroom training. The user can undergo these courses at his own schedule, learning style, and pace. MIT OpenCourse Ware, CAL PACT E-learning Software & National Programme on Technology Enhanced Learning (Funded by the Ministry of Human Resource Development, Government of India) are some of these. The learning material provided by them has video content which can be played on-demand by media players like Real Player, Windows Media Player or QuickTime. But these players are inflexible and do not consider the network bandwidth variations. Although different bandwidth versions of the same video (high, medium & low) can be made available, but this solution is also not acceptable as the video has to be encoded multiple times which is a time consuming process. Also, once a particular bandwidth profile has been selected (say medium bandwidth), it cannot be switched dynamically without interrupting the video. Thus, a streaming framework that can facilitate multiple rate decoding of the once encoded video stream will prove useful in this scenario. Multiple rate decoding combined with Network Bandwidth Estimation can dynamically adapt the video quality according to the changing network conditions, thus ensuring a pleasant viewing experience

Älykkö by Silander et. al., 2005 enables interaction and tutoring dialogue via mobile devices like mobile phones (SMSs) and PDAs, The study shows the requirement for a web-based open learning environment and cognitive tools for students. Liu et. al. 2006 provides a real-time content analysis method to detect and extract content regions from instructional videos and then adjusts the Quality of Service (QoS) of video streams dynamically based on video content. Similarly, Dong et. al. 2006 uses a content based retransmission scheme. However, the methods identify the video frames based on their content, and will not prove useful in cases where a static camera is used for recording the lecture session, as is usually the case. The specific case of mobile devices which are prone to fluctuating bandwidth is not dealt by these cases.

Some research has also been done for classroom videos. An approach to retrieve content pixels from the board regions by statistical modelling and classification is presented by Choudary et.al. 2006. However this method is computationally expensive and does not segment the video into a distinct number of visual objects among which the network bandwidth can be distributed. We have used a simpler approach to achieve real time yet robust e-learning video classification. Moreover, the regions having instructional content obtained by the other approaches have arbitrary dimensions which cannot be directly used with the CEZW compression scheme.

Smith et. Al 2005 studies the prospects of bridging the digital divides in education by wireless and mobile technologies. Our work enables to build a platform for sustained uninterrupted learning despite changes in mobile or wireless network. Information about the bandwidth availability in the network helps to adaptively adjust the transmitted data according to its importance from the point of view of the user. Much research has been done on bandwidth estimation and a number of tools have been proposed which can be used with our approach. These set of tools can be distinguished according to the two main approaches underlying the estimation techniques as the probe gap model (PGM), and the probe rate model (PRM).

3 OVERVIEW OF OUR APPROACH

We have classified the classroom lecture videos with a static camera into three main visual objects (VO): black board, teacher and the remaining background. We use a simple content based video classification scheme which classifies the video into distinct number of VOs. It is edge and pixel difference based approach. While simple, it provides efficient classification. We use simple rectangular visual objects to reduce complexity of the coder. The base and enhancement layers are discriminated for each VO based

on its significance. The bit stream for each individual VO is decided by the smart decision maker (SDM) block incorporated into the system. The backbone of this optimal resource allocation is the CEZW (Color Embedded Zerotree Wavelet) scheme used for video encoding. It offers a scalable tree shaped structure so that the bitstream is scalable and a single bitstream at the server can be transmitted at different rates to different users according to their network conditions. It receives an estimate of the available network bandwidth and then it optimally distributes bandwidth to different VOs based on relative significance and current motion in each VO. Fig.2 explains the working of server side of video transmission scheme.
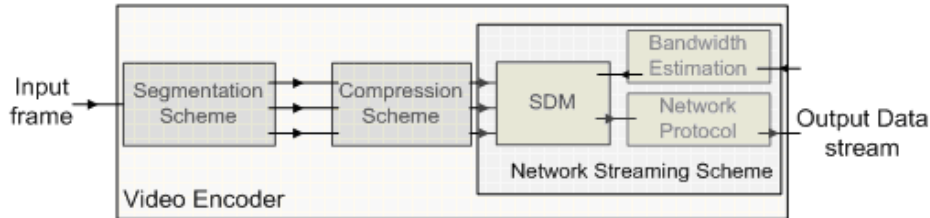
Figure 8. Overview of Video Encoding scheme

4. CLASSIFICATION & SEGMENTATION

A typical classroom lecture has Teacher Writing On board (TWOB) sessions (Fig. 1). These sessions have a teacher (complete view) writing on Black Board and explaining the class points to the students. Some special characteristics that help in identifying TWOB frames are: The complete board is visible, motion is slow, some students may be visible in the view and a significant part of the tutor's body may be visible in the frame (see Fig.1). The height of teacher in these frames generally doesn't vary much. They are classified into three visual objects: background, Black Board and the tutor. In this paper, we have modelled the background for static camera.

Modelling the background is an important task. For static camera, we need to reconstruct the region corresponding to the tutor. For the initial prediction of the background, we assume a set of frames that have significant tutor motion. Next we extract the background region by removing the teacher region. We find the pixel difference matrix of the two frames and enhance it to get two largest Visual Objects. Then they are removed to obtain the background image. This is explained in fig.3. Next we detect the horizontal and vertical regions and find the black board regions. Finally, we find the teacher region by comparing the present frame with the modeled background. Figure 4 shows the working of our approach on an instructional video.
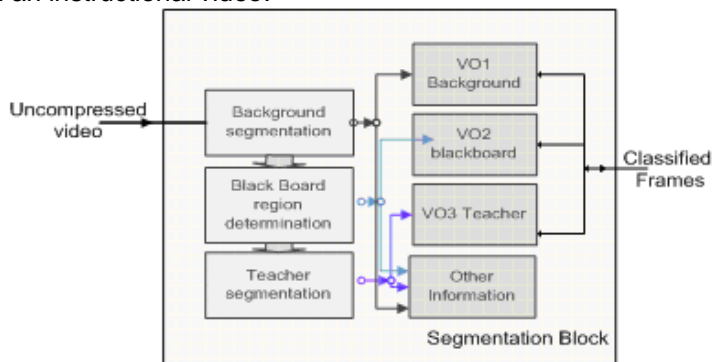
Figure 9. Overview of segmentation Block

5. COMPRESSION SCHEME

The different VOs obtained after segmentation are coded using a modified version of the CEZW algorithm as proposed by Delp and Saenz et.al. in 1999. This accounts for the rate scalability of the encoding process. The individual frames are first transformed to the YUV color space because of the following reasons:

YUV color components can be directly retrieved from MPEG encoded videos.

Luminance information is present in the Y component, thus U and V components can easily be discarded if color information is not

to be transmitted in case of low bandwidth.

The U and V components contain a high degree of redundancy and therefore can be CEZW coded after 4:2:0 downsampling. Since the maximum information content is present in the Y component, it is given more importance by coding at a bitrate that is s times the bitrate allocated to the U and V components where s is the scale factor.

If BR_{total} is the maximum bit rate of VO, and if we code the U and V components at the same bit rate, then we can write,

$$BR_Y = BR_{total}\left[1+\frac{2}{s}\right]^{-1} \text{, and}$$

$$BR_U = BR_V = \frac{BR_{total}}{s}\left[1+\frac{2}{s}\right]^{-1}$$
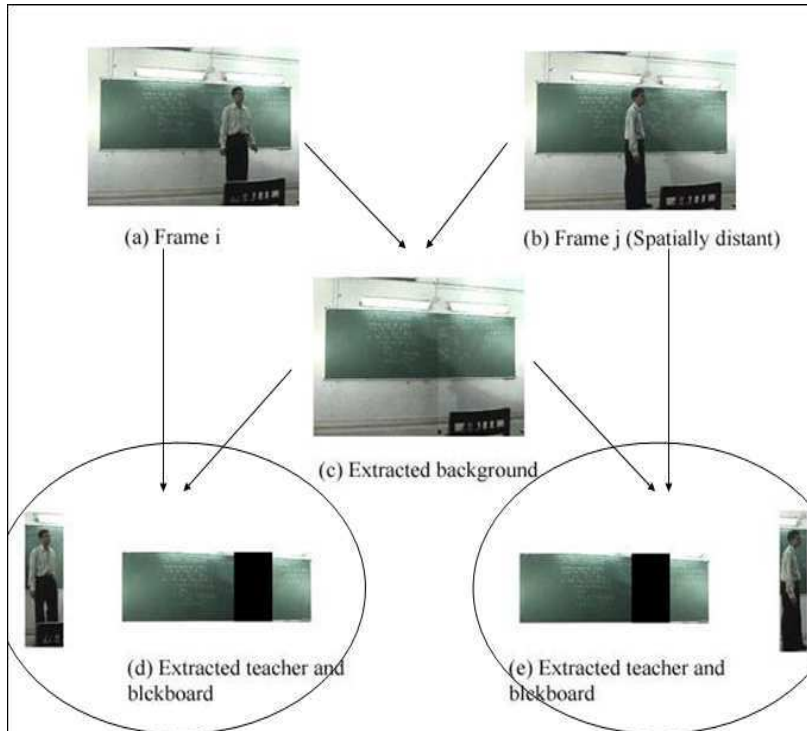
Figure 10. Segmentation of the instructional video into different Visual Objects (VOs)

where BR_y BR_U and BR_V are the bitrates available to the Y,U and V components respectively.

The compressed bit stream consists of the initial threshold T, followed by the resulting symbols from the dominant and subordinate passes of the CEZW algorithm, which are entropy coded using an arithmetic coder.

Figure 4 shows the overall encoding scheme for Mobile Video Learning system.
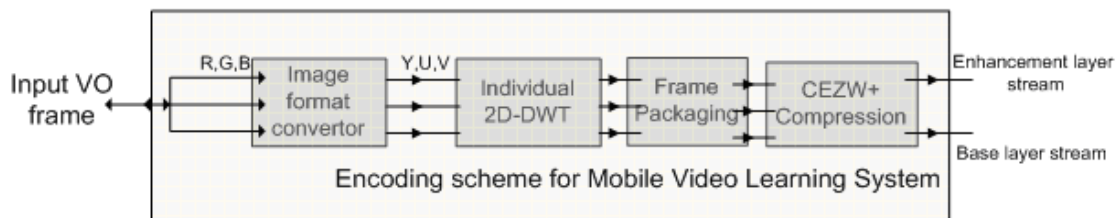
Figure 11. Overview of the Mobile Video Learning Encoder

6. HYBRID FRAME PACKAGING

A significant contribution in lossless video transmission is inspired by Apostolopoulos et. al. 2000. It provides an excellent yet simple way to handle the packet loss situation. We use this model to package the even and odd frame separately. Moreover, the even and odd frame packets are prepared temporally at a phase shift of 180^0. If N is the Group of Picture (GOP) size and if we assume the packet size to be equal to one GOP, then the I frames of even and odd sequences are separated temporally by *N/2*. Thus, we divide the even and odd frames into two groups and encode them separately. These two separate streams are then used for making packets as shown in fig. 5(a). In case of a packet loss, the even/odd frames can be used to reconstruct the frames in the lost packet by the use of motion vector interpolation. This reduces retransmissions and jitter in case of single packet loss. For example consider the loss of a frame *i* when the teacher is moving. When this is lost, we can generate a recovered frame by simply interpolating the motion vectors on the basis of the frames *i-1* and *i+1.* This is shown in fig. 5(b). The temporal spacing of I frames of even and odd frames at phase shift ensures a better distortion performance. The packaging of the I, B and P frames in a packet or GOP has been done similar to MPEG system.

6. DYNAMIC BANDWIDTH ALLOCATION

Dynamic bandwidth allocation module tracks the unpredictable bandwidth variations and then adaptively manages the bandwidth allocation to the different VOs according to relative importance and their present perceptible quality.

The working of bandwidth allocation module is illustrated with the help of figure 8. It uses UPD socket for video data transfer and TCP connection to pass information like user preferences, packet acknowledgement etc. UDP is needed for effective transfer of video data over an unreliable network. However UDP doesn't make the provision for packet acknowledgement that is important for Bandwidth estimation and other parameters. Hence the TCP based connection sends back the acknowledgement information.

The NBE (Network Bandwidth Estimation) tool used was developed using network profiling which helps in the accurate estimation of the available bandwidth.
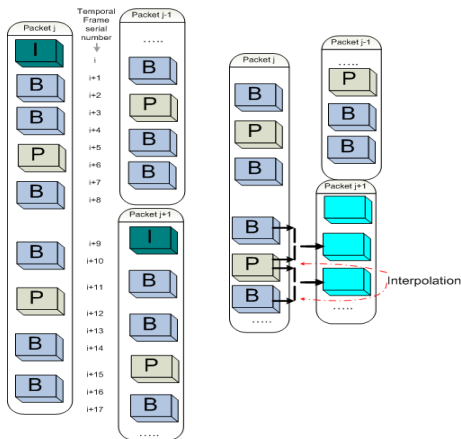
Figure 12. (a) Modified Loss resilient packaging scheme, (b) Frame reconstruction in case of packet loss

The video encoding is done using CEW scheme and the MSE of the encoded frames is also obtained to allocate bandwidth only to the important sections of video. The different VOs are transmitted at different visual quality according to available bandwidth and motion and significance of VO.

7. EXPERIMENTAL RESULTS

Motion estimation and compensation blocks, CEZW coder, arithmetic coding and SDM modules were simulated on Matlab7.

Codec	Bits per pixel
Microsoft MPEG4 V2	0.58
Windows Media	0.51
MPEG2	0.88
Our algorithm	0.16

Table 3 .Performance comparison of different codecs for IITR video sequence (PSNR=35)

(a) (b) (c) (d)

Figure 6. Reconstructed frames for a GOP (a) frame 21 (I frame), (b) frame 22, (c) frame 24, (d) frame 28 at 0.6 bpp without segmentation and bandwidth allocator.

Figure 13. Reconstruction of frame 24 at (a) 0.1bpp (b) 0.2 bpp (c) 0.3 bpp (d) 0.5 bpp with bandwidth allocator and segmentation

Figure 14. Reconstruction of frame 24 by (a) Microsoft MPEG4 V2 (b) Windows Media (c) MPEG2 (d) Our algorithm.
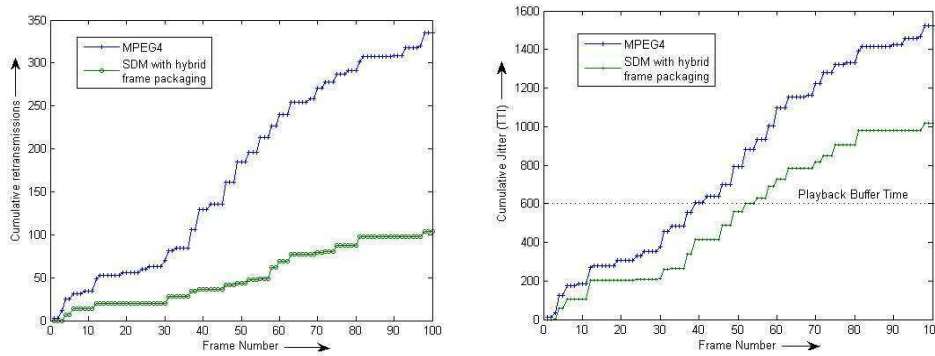
Figure 15 Comparison of (a) retransmissions and (b) Cumulative Jitter in MPEG4 and SDM with hybrid frame packaging

Figure 6 shows the propagation of error along a GOP. As frame number increases, even at high bpp values reconstruction error becomes visible. Fig. 7 shows the reconstruction of frame no. 24 at different bpp values using SDM and segmentation. Some distortions are evident at lower bitrates. However, even at 0.5 bpp the reconstruction error is very low. The GOP size was taken as 10. As illustrated by fig.7 its use enhances the quality of reconstructed video by optimally allocating the bandwidth.

Fig. 8 shows the change in perceptual quality of the reconstructed frame no. 24 by different commonly used codecs at the same value of PSNR, which is taken to be 35dB for each of these codecs. The frame numbered 24 corresponds to a frame with significant teacher motion. Table 1 shows the bit rates used by different standard codecs. Our algorithm shows significant improvement over others. Thus, the bandwidth allocator optimally allocates greater part of the bitstream to the teacher region and obtains good reconstruction of the frame even at low bpp.

To test the hybrid frame packaging scheme, a wireless network of 7 nodes was set up on Network Simulator-2 with one node acting as an access point. Our scheme yields excellents improvements over existing approaches making its use preferable over mobile networks which are error prone.

8. CONCLUSIONS

This paper shows how the available bandwidth can be optimally distributed to the different visual objects based upon their perceptual importance and motion. It also shows how the concept of even-odd frame packaging can be modified to achieve better video quality in case of packet losses. The framework achieves a high degree of compression with better performance in terms of jitter and the number of retransmissions. This framework is highly conducive for the development of applications of mobile learning as it intelligently handles the issues of packet errors and flunctuating network bandwidth.

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STUDENT REVISING FOR A TEST USING SMS

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ABSTRACT

In this paper an experiment involving mLearning using Short Message Service (SMS) is described. The experiment was designed after a study of the readiness of the participants in terms of mobile device ownership, mobile technology preferences, and learning styles. Qualitative data was gathered and analysed using an activity theory framework. The SMS scenario developed for the experiment is content-specific and was provided as a commercial service in 'pull' mode. The study allowed to conclude that mobility support, information density, and information relevance were the factors which contribute most to creating mLearning value while cost was a major detractor.

Keywords
SMS learning scenario, mobile learning, mLearning, mobile business, activity theory, value, just-in-time learning.

INTRODUCTION

As Short Message Service (SMS) is arguably the most accessible mobile data service, it is viable platform for mobile learning (Sharples, 2005; Taylor, Sharples, O'Malley, Vavoula, & Waycott, 2006). Additionally SMS adds to mobile learning (mLearning) features of just-in-time learning (Hall, 2001), and can blend easily into courses delivered in mixed or flexible) learning environments (Divitini, Haugalokken, & Morken, 2005; Wuthrich, Kalbfleisch, Griffin, & Passos, 2003; Song & Fox, 2005). A classification of mLearning scenarios involving SMS is proposed in (Petrova, 2007b). Examples of a contextualised learning experience with participants engaging in activities facilitating knowledge acquisition can be found also in (Petrova & Sutedjo, 2004; Evans & Taylor, 2004). Specific scenarios for using SMS in tests, quizzes, and questions and answer sessions are reported in (Capuano, Gaetta, Miranda, & Pappacena, 2004; Iliescu & Hines, 2005; Mellow, 2005; Ng'ambi, 2005; Riordan & Traxler, 2003; Tretiakov & Kinshuk, 2005; Silander & Rytkonen, 2005). Most of the reviewed scenarios are not tied to a particular event timeframe and are driven by the provider ('push' mode) rather than by the leaner. This paper presents and discusses an SMS scenario which is both learner-driven (i.e. it works in 'pull' mode) and context-dependent (students are studying for a pre-scheduled, assessed test).

BACKGROUND AND METHODOLoGY

In 2004, a study of the mLearning readiness, preferences and learner styles of selected undergraduate students from the Auckland University of Technology (New Zealand) was carried out (Petrova & Sutedjo, 2004). Data about the ownership and the use of mobile devices indicated that students were ready to participate in mLearning and that their mLearning technology of choice was SMS. Students surveyed identified themselves as either 'concrete experimenters' or 'active experimenters/decision makers'. Based on these results an experiment with a scenario for SMS-based mLearning was designed (Petrova, 2007a). Two separate research projects were conducted a) an independent quantitative study of mLearning adoption applying an acceptance model, and b) a qualitative study investigating how mLearning adds value to the learning process (using the feedback provided by the participants in the experiment). The experiment design and the research framework used to analyse the data collected in the second study are presented next.

Experiment Design

The scenario chosen was that of SMS-based test revision. In this scenario students would still have to construct their own knowledge based on independent work with resources but they would be also able to check whether they had understood and applied the concepts correctly. The mLearning scenario was implemented as a cost-incurring mobile business service, but participants were reimbursed up to a certain limit. The experiment was piloted first in 2005, with second year undergraduate students. Valuable observations about participant recruitment and the timing of the experiment helped fine-tune the set up prior to the final run in the second half of 2006 (the second semester of the academic year).

The platform used (StudyTXT©) was developed independently (Mellow, 2005). It allows a 'pull' type SMS study service to be set up, as follows: The revision material (i.e. the answers to revision questions) is packed in the form of short, up to 150 character messages hosted on a dedicated SMS server. Users can request the answer to a question or to a group of questions by texting a unique code to the server. The server responds by sending back the response(s) to the student's phone. As messages can be stored, the answers to the questions, once received, can also be shared with others. Formal user

enrolment is not required - the platform payment model utilises the existing billing or pre-payment mechanisms of the interoperating mobile subscriber networks. The conceptual design of the experiment is shown in Figure 1.
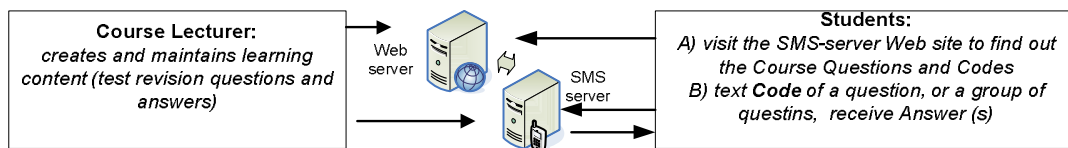
Figure 1. The conceptual design of the 'SMS-revision for test ' experiment.

Research Framework

Activity Theory (AT) provided a framework for the research. An activity can be represented as a set of interactive components (Figure 2, adapted from Koszalka & Lu, 2004). The aim is to reach a goal with the subject motivated to achieve the object by using the tool in a specific context (rules, community factors, division of labor).
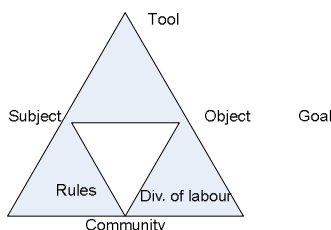
Figure 2. The Activity Theory framework (adapted from Koszalka & Lu, 2004).

As AT emphasizes the mediating role of the context and the tool, it provides a suitable framework for studying the dynamics of technology enabled learning (Scanlon, Jones, & Waycott, 2005; Sharples, Taylor, & Vavoula, 2005; Uden, 2007). The AT components of the experiment interpreted as an activity are identified and described in Table 1.

AT components	SMS-based revision mLearning experiment
Tool	The SMS-based test revision as set up by the lecturer.
Subject	The student participants; the lecturer.
Object and Goal	The object is to facilitate revision. Intended goal: success in the test. Any negative experiences during the experiment are 'unintended' goals (possible barriers to learning).
Rules	Paid service, available anytime anywhere. Funded by UUU to a set limit.
Community	Answers can be shared among student participants.
Division of labour	Learning content is prepared by the lecturer; students assume that it is relevant to the test.

Table 4. Activity theory framework applied to the SMS-revision experiment.

Data collection

Qualitative data from 50 student subjects (second year undergraduate students enrolled in two information technology related courses) were gathered at the end of the semester through an anonymous course evaluation form. The participants were asked to comment on how they felt SMS revision had helped them, how and when they used it, what problems had occurred, and what might need to be changed for better results.

Findings

In the evaluative feedback students reflected on their experiences. It was found that student responses referred to four AT components: a) the tool; b) the object and the goal; c) the rules, and d) the community factors.

Tool

With regard to using SMS as a technology, student participants particularly appreciated its 'anytime and anywhere' aspects: Comments include "I found it most useful when I was on the bus and in bed", "this feature is useful when you are not at your computer or in your study area", "convenient to have answers in the mobile and have a look at it at anytime", "mobile phone is natural", "actually having the answers on your phone is handy", "I could keep the answers on my phone, allowed for revision on the bus etc. So it was great I could study in places I usually could not"). Some negative experiences were related to interruptions in the connection ("facing technical problems not helpful when you have exams close", "the service seemed to be inaccessible …when I wanted to use most"), to the need to store large amounts of data ("message box exceeds capacity", "I receive a lot of txt in very short time and my phone is out of memory"), and also to the need to access the Web server to retrieve the revision questions ("it seems funny to get the …list off the web and then text"). However there were also comments positively evaluating the combined use of the Web and SMS ("I think a combination of SMS and web revision would work the best", "it could be developed to be used together with Internet to provide longer answers and explanations").

Object

Most students had understood the object well and felt that the object did help them achieve the goal ("I think it must be stressed though that it provides a foundation for studying more rather than covering the entire line of topic"). The format was found appealing ("particularly useful in obtaining short definite answers", "I loved SMS. I especially liked the definite, to the point answers", "It was good how it stated the question in the answer", "saves time", "if you do not know the answer, quickly to find – for just in time, reasonable", "responses covered a good selection of material and were of a good length, and clearly explained the question without over elaboration"). Negative experiences included dissatisfaction with the perceived level of difficulty ("some questions – their answers were not simple to remember"), and the relative brevity of the answers ("useful, however answers need to be explained in depth", "could expand questions and add supplemental sources").

Rules

 Students needed to be proactive during a predefined time interval in order to make use of the service; the experiment timeframe and the mode were perceived as appropriate ("Good way to study for revision", "Goes through the topic, given the opportunity to try to answer for yourself, or if you do not have the time – to do it quickly"). Most of the critical comments referred to the cost of the service ("Good idea, would definitely use if it were cheaper", "I would only use it if it was free or near free", "50 cents per question is too expensive", "I would not pay 20 cents per message", "I think it should be around the 2-5 cents mark").

Community

The positive effect of community factors was evidenced by the evaluation of the opportunity to share question answers with others ("it is very good because it is very easy to exchange with others"). However not all participants seemed to value the option to share too highly ("did not share as though [we] were not friends"); some were prevented form sharing by the cost barrier ("I doubt students would collaborate together to exchange txt-s, as most people are on different networks so it would still cost 20 cents").

DISCOUSSION

An mLearning application offered as a paid service can also be categorised as mobile business informational application The defining feature of a mobile business application is the provision for user mobility which involves seamless and uninterrupted use of an 'always on' service. The two other features playing a critical role are 'information density' (specific, precise and concise information) and 'information relevance' (expected and anticipated information, needed to support a concrete activity) (Petrova, 2007a).

The findings of the study confirm that support for user mobility (using the ubiquitous 'texting') was most highly valued by students, consistent with with Sharples et al. (2005) and Scanlon et al. (2005) who underline the importance of enabling the mobile user to learn anywhere and anytime. The service was perceived as useful because it provided specific information in a condensed format and was available when expected. Therefore mobility support, information relevance and information density can be construed as value contributors in the context of the experiment.

The analysis of the data using the AT framework revealed some contradictions related to the components: With respect to the object, not all participants had fully understood the object and its relationship with the stated goal (i.e. not so much new knowledge acquisition but checking and improving one's knowledge in order to prepare and gain confidence for the test). With respect to the tool, network problems may have caused interfered and as a consequence the information may have not available when expected.

Further contradictions were identified within the context: First the usefulness of the service was offset by what was perceived to be the 'unreasonable' cost. Secondly, information sharing did not occur on a large scale although it was technically feasible and might have been cost-decreasing. Reasons for not sharing as provided by the participants included the cost, and the lack of a pre-established social network. Finally device limitations (memory) may have prevented downloading groups of responses which would have been cheaper compared to receiving individual texts.

To summarise, two groups of barriers to mLearning were identified: technological (network availability, device features) and socio-economic (cost and the lack of a learner community). The pedagogical approach was successful with respect to the informational features of the service (density and relevance), however a better 'promotion' of the expected outcomes might have led to a higher level of acceptance. The AT model used to analyse the contradictions between and within the model components provided a mechanism for identifying some of the barriers and the success factors to the adoption of the specific SMS mLearning scenario. As Uden (2007, p. 86) noted "activity theory sees contradictions not as problems but as sources of development". The process of working through contradictions in a specific context may therefore help design and develop new mLearning scenarios and models and extend the object to meet better the learner's needs. .

CONCLUSION
The AT model applied in this study allowed to identify mobility support, information density and information relevance as the most significant mLearning value contributors, and cost – as the major detractor. Even the sporadic lack of network reliability may play a critical role in a time-critical context. The experiment was successful and could be even more useful if participants had already formed an active social group and if all participants had completely understood the object of the mLearning revision activity.
The study has a number of limitations: Despite the efforts it was not possible to conduct a sufficient number of in-depth interviews with students. Secondly, as participants were studying the same discipline (information technology), the results may be biased towards a certain type of a student. Data about lecturers' experiences were not collected. However it is hoped that the results presented here will encourage further research as well as practical mLearning endeavours.

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DESIGNING A MOBILE GROUP BLOG TO SUPPORT CULTURAL LEARNING

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Abstract

On the basis of a case study of new Chinese students coming to UK, culture gap was found to be a barrier in getting used to the new environment. The design of this mobile group blog to support enculturation is based on the needs assessment study on group blogging. This paper reports on the design process for a mobile-enabled group blog that could assist a group of students handling problems they encounter after arriving and support them towards entering the local community as soon as possible. In the design process, learners showed a obvious interest in flexibility of time and space that potentially extends 'antennas' of the group blog to deeper insight of local culture.

KEYWORDS

Mobile group blog, inquiring, learning community

Introduction

As reported by the BBC (2005), the largest single group of overseas students in UK is Chinese. Some students gave comments on their study experiences in UK that indicate the scale of what must be learned: "Study abroad is not only to learn professional knowledge and skills in class. We should not neglect the local community we are in. We should learn more" (Li, 2005). An investigation by the China Study Abroad (CSA, 2004) indicated that as well as language capacity (76.7%) and professional knowledge (74.1%), which are at the top of their intentions, local culture (52.6%)and networking skills (36.4%) are also regarded as key challenges.

Cultural new comers as "learners"

Different habits, different traditions, different manners (or cultural gap) always are barriers to communication for newly arrived Chinese students. In this research, we regarded these overseas students as *learners* who need to get used to the local environment, get along well with people locally, at the same time, to get into the community and gain insights from local culture.

"*People may not understand what you said, what you did due to language or other cultural reasons. And I can't understand their words and sometimes their behaviours, either.*" (Postgraduate student, University of Nottingham)

New students found problems mainly come from: (1) Language: the significant barrier is that most students still found it difficult to understand local English because of different accents other than Standard English they'd learned. (2) Accommodation: In contrast to the multi-beds dorms in universities of China, students who come to UK to a private room are definitely suddenly isolated. This leads to loneliness. (3) Timing: students have to learn the timing habit of British people, learn how to schedule their spare time for more activities in local society as well having good time management on their studies.

Mobile group blogs

This research explores the design patterns of a mobile group blog that would enhance local cultural learning and so encourage learners' communications with local people. A group blog generally is a group of people gathering, contributing, discussing and sharing information within an online blog on specific topics or focus issues. Unlike personal blogs, the defined topic or targeted issues more or less imply the purpose of grouping. Building up a group blog also encourages the formation of an online community (Lambropoulos & Zaphiris, 2006) in which different group members can play different roles at different times. Moreover, with those contributions it could be regarded as a reflective learning resource forming a social learning network (Trafford, 2005). The mobile group blog will bridge the virtual and real society by different activities conducted by people with different roles in this group (Shao, 2007).

Mobile devices provide students opportunities to "capture the moment" "on the spot". Those contributions collected and recorded can be kept in the online site as resources for new group members later on. Otherwise, tools and the way learners used them reflect the particular accumulated insights of communities. They should understand how to use a tool appropriately together with the community or culture in which it is used (Brown, Collins *et al.*, 1989).

Method

We conducted a field study to collect the students' intentions and requirements for cultural learning and technology assistance in general.

A case study

A study on the adaptive needs of new students was carried out on 16 newly arrived Chinese overseas students in Nottingham who were pursuing degrees from Undergraduate to PhD. They were asked to keep diary records and post them to a group blog. They used digital cameras to capture and collate personal experiences and coordinate with others through the group blog. This was started one week after their arrival and lasted for 3 weeks.

During the three weeks, 120 logins were found, 77 articles were posted onto the group blog in forms of texts and images and 72 comments were given while the total number of blog hits was 254. They shared good or bad news happened in their lives, their excitements about travelling, their agony or difficulties on learning, their viewpoints on changing to a new culture, their life style changes in new accommodation and so on. 14 of those participants joined subsequent interviews and focus groups concerning their experiences of that group blogging after the practical case.

Feedback was also collected through interviews and focus group. Audio recorders were used to record those conversations, along with field notes. The group blog was first a general blog with no specific educational purpose. Through the observations, investigations and data analyses in this study, new directions were identified.

Activities in the group blog
From the case study, we found learning activities in the group blog can be classified as following. In the process of a group blogging, learners experience different levels of learning according to different types of learning activities.

Stage 1: *Awareness*. Most students had intentions and motivation to learn local culture through their trips. By exploration of the natural or the constructed/social culture in UK society, learners tended to questioning and seeking of new understandings. They shifted from learning incidentally to knowledge inquiry.

Stage 2: Information gathering. Learners had certain awareness of culture that raised specific questions. Having explicit questions in mind, inquiring begins with gathering information (Exline, 2004) in their own personal way about something worthy of looking at (Nemirovsky, 1992). Participants in our case study were quite interested in authentic collection of evidence in context via a mobile device.

Stage 3: Information transfer. Those students who participated in this study thought it great fun and valuable to transfer what they recorded instantly to the group blog through a mobile blog. Also they learned the culture of blogs by joining the community of using the group blog.

Stage 4: Information sharing. In the case group blog, learners found it helpful for practising English. They used either Chinese or English for blogging and commenting. Through this community, the loneliness of individuals might be reduced. Participants created learning materials for the whole group based on their own experiences or through other participants' activities in real UK culture, contributions, and the environmental cues (Stein, 1998). In this sense, learners are better engaged in learning by facilitating learning resources to the group blog, which is developed little by little for other group members.

Stage 5: Feedback. Learning is the sharing of the narratives produced by this group of learners by reflecting, interpreting and negotiating meaning among the participants of the community (Lave, 1988) What's more, the higher-order thinking processes improve habits of mind to quest for knowledge in new changing environments. The loop learning process promotes the abilities and good habits of mind of learners to be more sensitive to cultural differences and to enhance their learning. This would give them a push for more communication with more local people in order to enrich their knowledge. Knowing the importance of events happening, they would know how to arrange their time properly in a certain sense.

To conclude, we found their activities also link to types of learning which we try to support through the design.

Stage	Learning activities	Types of Learning
1	Sensitive to objects and aware of interesting happenings	Incidental learning
2	Questioning about the world, gathering information and data with mobile devices	Inquiring information in social context collaboratively (f2f in pairs, through calls etc)
3	Transfer information to blog site understand the culture within the mobile community	Technology mediated
4	Share information on blog site	Semi-facilitating of learning resource, situated in a virtual community context
5	Comment and discuss on blog	Peer review in the learning community Knowledge recall and reflection

Cultivate good habit of mind, enhance the awareness of learning

Table 5. Parallelism of learning activities and types of learning

Technology and the website sketched

A group blog site system running on PHP was reworked from Wordpress[3] and specifically redesigned for the learning purpose. We decided to add mobile features to the group blog. With an Internet-access enabled mobile phone, pictures can be uploaded together with texts to the group blog on a server host by visiting the certain website from a mobile phone. The information channel is shown as below:

Data collection& recording

Data selection

Data transfer via network

Comment

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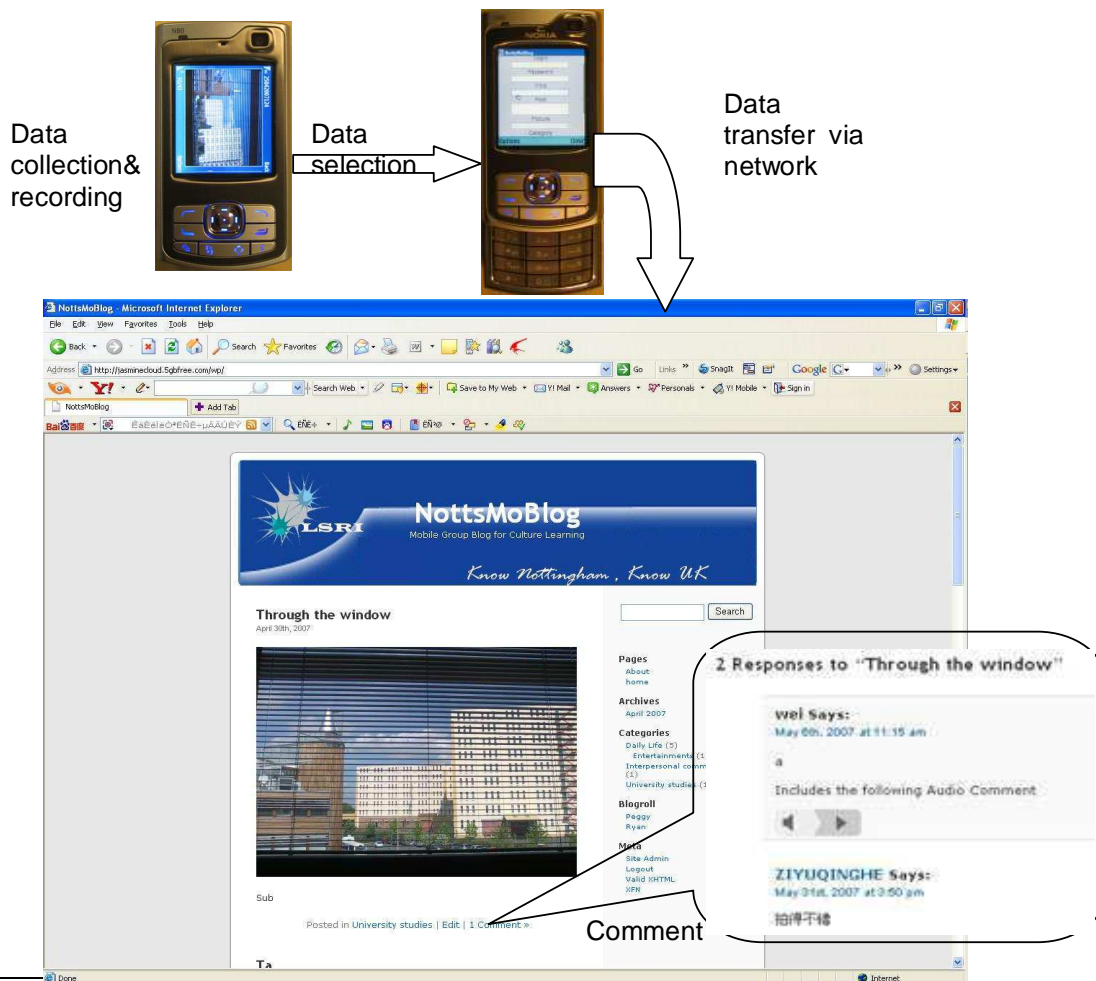
[3] A free blog tool and weblog platform

Roles Design

Good information structure and management in the group blog were heavily required by learners in the case study.

According to the different requirements in different stages of mobile group blogging, we now set particular roles who are as following:

Administrator (teachers & facilitators): people who are responsible to maintain the whole group system and scaffold learning of both technology and contents

Editor (group leader): senior learners who have the right to filter and reorganize learning materials posted to the group blog by gathering suggestions from group members.

Author (Bloggers): All learners are readers and authors themselves, either on the move or from fixed PCs. They can capture what they want freely and share instantly by mobile phones, write and read blogs, manage their own posts and comments by deleting, adding or categorizing.

Subscriber (Readers): Learners at this stage are still information receivers in the group blog community who only have the right to read blogs, join comments and discussions. They can be, for instance, the very newly-arrived students.

Conclusion and Future Work

Learners in the case study found they got useful information and thought it interesting to share others' experiences in group blog community. They thought the group blog is a new bridge posing to the real local community with extended 'antennas' by other people. They all held positive views on making the group blog 'movable' with mobile devices. Evidences collected in the form of visuals and texts immediately with mobile devices would make the understanding of the local culture clearer and more trustful. "Learning will be more involuntarily flexible," as they said.

The initial design is nearly completed. 5 -6 current students now staying in Nottingham will be asked to collect necessary information in advance via Nokia N series mobile phones to scaffold the group blog, while the designer also wants feedback to improve the mobile group blog before it is put into practical experiments. More features such as audio collection and audio comments, which are potential supplementary tools for language adaptation, are being added. The design is formed and re-formed over and over in terms of feedback. A new study with the prepared mobile group blog will be started at the very beginning of new semester. Again 20 new volunteers will be recruited. 5-6 new learners' outdoor activities will be recorded by video as samples. Some records of their activities online such as visiting frequency, number of posts and comments online will be tracking automatically by the host. 5-6 participants' movements and activities at PC's side will also be tracking and recorded.

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EDUCATIONAL AFFORDANCES OF HANDHELD DEVICES: UNDERGRADUATE STUDENT PERCEPTIONS

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Teachers and researchers understand student needs and preferences better, which in turn, will help improve handheld pedagogical practices and wider handheld applications in education.

Affordances refer to "what it [the environment] offers the animal, what it provides or furnishes, either for good or ill" (Gibson, 1977, p. 127). Though the Gibsonian concept of affordances developed from an ecological approach to perception, it emphasizes possible actions that the observer perceives as feasible

ABSTRACT
This paper reports on an empirical study into undergraduate student exploration and use of the affordances of handheld devices for educational practices in higher education. In previous studies, affordances of handheld devices have focused mainly on exploring designed research or experiments, in which students have used handheld devices for prescribed learning tasks. This study investigates student free exploration and use of affordances of handheld devices for learning. Five students over a six-month period were involved in this study. Nine emerging educational affordances of handheld devices were identified and are discussed, and implications regarding these affordances and the need for further research are explored.

INTRODUCTION
In recent years, handheld devices have been increasingly developed, designed and used in education in varied contexts. They have been used as a technology tool for encouraging classroom collaborative learning (Zurita & Nussbaum, 2004), supporting experiential learning in field (Lai, Yang, Chen, Ho, & Chan, 2007), making anytime, anywhere learning happen by course content delivery (Thornton & Houser, 2005), supporting lifelong learning (Sharples, 2000), enhancing interactivity both in/out of class via a messaging system (Markett, Arnedillo Sanchez, Weber, & Tangney, 2006), and helping improve administrative work via a handheld testing system (Segall, Doolen, & Porter, 2005). A majority of these applications have been carried out in the context of limited empirical studies, in which students have used the handheld devices for pre-defined tasks. In addition, the research findings, in many cases, are derived from restricted data such as pre-tests and post-tests, questionnaires, or interviews during a short period of time. Though these research results provide some references and recommendations for future educational research, there seems to be an emerging need for exploring the affordances of handheld devices perceived by students themselves. This will help in the environment (Gaver, 1996), and is interpreted as the possibilities for action (e.g., Young, 2004, p. 171). Based on this definition, it can be understood that affordances contain two fundamental connotations. First, affordances are the perceived possible uses of the thing. Second, affordances emerge in human-environment interactions. To put it another way, affordances can be perceived and used only when there is interaction between the actor and the thing in the environment or in context (Gaver, 1996). Therefore, affordances of handheld devices are defined as *perceived possible uses* of handheld devices in context in this paper.
In the sections that follow, we review the literature of educational affordances of handheld devices, introduce the research methods, present the research results, discuss and draw up conclusions. Finally, implications are made.

EDUCATIONAL AFFORDANCES OF HANDHELD DEVICES
Affordances have been explored not only in a human-computer design process (e.g., Norman, 2002), but also in the area of information communication technology (ICT) applications in education to investigate the possibilities that computer technologies provide for students in ICT-based learning environments (e.g., Laurillard, Stratfold, Luckin, Plowman, & Taylor, 2000). Handheld devices, like other ICTs, can also provide many affordances in handheld learning environments. Klopfer, Squire and Jenkins (2002) describe five properties of handheld devices that produce unique educational affordances. They are (a) *portability*; (b) *social interactivity* (data exchange or face-to-face collaboration), (c) *context sensitivity* (real or simulated data gathering unique to the current context), (d) *connectivity* (handheld connection to

other devices or network to form a shared environment), and (e) *individuality* (individualized scaffolding in the individual's approaches to investigation). In recent years, taking advantage of these educational affordances of handheld devices, a host of research studies has been accomplished to use the handheld technology as a tool to empower teaching, learning, training and administrative work outdoors, indoors or in mixed environments (e.g., Lai et al., 2007; Swan, van't Hooft, Kratcoski, & Unger, 2005; Thornton & Houser, 2005). Based on the literature of handheld educational practices, Patten, Arnedillo-Sanchez and Tangney (2006) have developed a functional framework containing seven categories of handheld educational applications, namely, (a) administration (e.g., calendars, contacts); (b) referential (e.g., dictionaries, translators and e-books); (c) interactive (e.g., drill and test); (d) microworld (e.g., constrained models of real world domains); (e) data collection (e.g., note-taking, data logging); (f) location aware (e.g., museum guides and augmented reality); and (g) collaborative (e.g., knowledge sharing). In this classification, *referential*, *data collection* and *location aware* are categories of activities using handheld devices rather than affordances, as those categories are not the relationship between an actor and the handheld environment that offers potential for action. Churchill and Churchill (in press) did an empirical study on examining educational affordances of PDAs from classroom practitioner's efforts, and found five educational affordances: PDAs as (a) *a multimedia-access tool* (e.g., getting access to e-books, web pages, presentations, interactive resources, audio files); (b) *connectivity tool* (e.g., exchanging ideas and files, collaboratively build understanding); (c) *capture tool* (e.g., capturing videos and still photographs); (d) *representational tool* (e.g., creating representations that demonstrate their thinking); and (e) *analytical tool* (e.g., using scientific and graphic calculators to aid students' tasks). These are useful findings though further modifications and expansions are necessary.

A clear articulation of these affordances will enable us to understand better how these technologies can be most effectively used to support learning and teaching (Conole & Dyke, 2004). The Gibson' (1979) ecological psychological perspective is often cited as the basis for the "situated cognition" approach to thinking and learning (e.g., Young, 2004). It focuses on how the agent actively detects and uses the possibilities that the environment provides. According to Patten et al. (2006), the potential of handheld devices has not been fully exploited. Gibson (1979) assumes that the environment as a whole provides unlimited possibilities for us to make use of. Further research is needed to investigate possible uses of handheld devices for educational practices using simple features of the technology, as these affordances may "become powerful educational interventions" (Roschelle, 2003, p. 268). Up to date, research into student free exploration and use of handheld educational affordances remains rare. This study, therefore, investigates affordances of handheld devices emerging from students' own perceptions. The key question asked is: What affordances of the handheld device emerge from student perceptions?

Research Design
As this study investigates handheld educational affordances emerging from student exploration and use, a qualitative research approach that explores the process of how actions or events take place was adopted. Miles and Huberman (1994) argue that adopting a multiple-case study approach for understanding a complex and dynamic phenomenon offers "the researcher an even deeper understanding of processes and outcomes of cases, the chances to test (not just develop) hypotheses" (p. 26). In addition, the authors assert that multiple-case sampling adds confidence to the research findings. This is in line with Merriam (1998), who advocates multiple-case studies from the perspective of enhanced validity by triangulating the findings, and Yin (2003), who insists that the precision, validity and stability of the research findings are strengthened by using multiple cases. Five students as individual case studies were investigated over a six-month period.

The Participants
Participants were selected purposefully from first-year undergraduate students at one university. In the university, free wireless access was available on campus and in the university dormitories. Three steps were involved in the sampling process: (a) an orientation seminar aimed at introducing the research project to interested students and conducting a questionnaire survey in terms of student demographic information and their perceptions of computer technology use; (b) focus group discussions were conducted to finalize the sampling process; (c) Five participants were chosen for this research study aged between 19-20 from different disciplines and departments, namely, Journalism (Sally), Nursing (Ann), Engineering (Andy), Translation (Sam), and Bio-technology (Evan). All males (3) had prior experience of using a PDA of various types, whereas, the females (2) had no prior experience. Sally came from Mainland China, while all the other students were Hong Kong permanent residents.

Handheld Devices

The handheld device adopted in this research was the wireless enabled Dopod 818 Pro with both phone and PDA functionalities. It supports 2 G mini or standard memory cards. In this project, each student was provided with one 1 G mini memory card for free use. These devices were distributed to students for one-year free use. A one-year package of mobile phone telecommunication services was granted to the students in order to encourage them to make good use the devices. Students could access the Internet using the handheld device on campus and in university dormitories. They could also use the handheld device to get access to wireless Internet when they were

Figure 1 Dopod 818 Pro

Data Collection and Analysis

Before the start of this research project, the researchers asked the five students to sign the consent forms in participating in this project, and a plain language statement outlining the research focus, confidentiality, terms of participation, and student right of withdrawal. Each student was provided with a Dopod 818 Pro handheld device. A few days later, an experienced technician introduced various uses of this handheld device. The researchers then briefed participants on the research study. Data collection and analysis lasted six months. Three methods were adopted: student electronic journals, student artifacts and interviews were the main means of data collection. Content analysis was used to analyze the data collected at different stages.

Student e-journals focused on students' reflections about their exploration and use of the handheld device. A guide was provided for writing of e-journals based on the focus of the study and to ensure that students considered and wrote up comments relevant to the research project. These e-journals were intended to be used as 'introspective tools' in the research giving the researchers access to 'the student's voices' (Nunan, 1992, p. 118). Participants were asked to submit their reflective e-journals to an online learning management system at least once a week for six months. After one month, a preliminary content analysis using participants' sentence descriptions as a unit of analysis was conducted to identify emerging affordances of the handheld device by each participant. In the sixth-month, another analysis was carried out to check whether previous perceived affordances of the handheld device were continually used, and to trace other emerging affordances and constraints of the handheld device reported by the participants.

Student artifacts in this research refer to screen captures or files that participants made or carried out using the handheld device. Collecting student artifacts was acknowledged as an unobtrusive method (Savenye & Robinson, 2004) for obtaining information about what students do using the handheld device but was still considered worthwhile. From the artifacts that participants submitted, the researchers were able to triangulate the perceived possible uses of the handheld device they mentioned in their e-journals and interviews, and were able to trace changes of use by the participants over time (Hodder, 2000). Some handheld educational research studies have employed this technique as a data source collection strategy (e.g., Swan et al., 2005). Guidance with an example of the artifact was provided for the participants.

Two semi-structured individual interviews were conducted after the participants had used the handheld device for one month and six months respectively. In the first interview, questions were centered on: (1) what perceived possible uses of the handheld device did participants find for their learning? (2) how did they find and use them in varied contexts? During the first interview, the participants were asked to show the researchers some of the handheld uses they made. Their demonstrations were video-taped. Emerging affordances were identified through content analysis taking statements of the participants as the unit of analysis. Before the end of this research study, another semi-structured interview was conducted. Questions mainly focused on: (1) what handheld uses participants often adopted? and what handheld uses they seldom adopted? (2) what new perceived possible uses of the handheld device did they find? (3) how did they find and use them? A questionnaire in terms of the frequency of participant use of the emerging affordances was filled out to triangulate Question 1. The analysis of the interview data helped the researchers gain a better understanding about how affordances of the handheld device were explored and used from the perspective of the participants. A list of affordances emerged from the five participants.

RESEARCH RESULTS

The educational affordances perceived and used by the participants in this research were: *revision, reference, multimedia collection, multimedia access, social interaction, managing, data processing, connectivity* and *representation*. They are further illustrated as follows:

Revision – Perceived possible uses of the handheld device for reviewing course materials and examination papers, listening to recorded lectures without time and place constraints.

Some students such as Sally and Andy reported that they considered that this device was useful for course revisions. However, their uses were different. Sally studied journalism. Many of the courses concerned had reference materials and lecture notes for them to download and review. As soon as she joined this project, she explored the possibilities of downloading and saving lecture notes in the handheld device and reviewed them at her convenience. As many of the lecture notes were in Word or PPT file she could read them on the device. Andy, reported that for course revision, because most of the lecture notes in his department were in hardcopy, he mainly used the device to record and listen to these recorded lectures or tutorials that he considered hard to digest out of class time.

Reference – Perceived possible uses of the handheld device for referring to e-books, dictionaries, downloaded materials for anywhere, anytime learning support.

Students frequently reported that they referred to downloaded dictionaries to check new words and expressions encountered. Using the handheld device to get access to the dictionary helped students resolve vocabulary difficulties in academic reading or other academic activities. Evan mentioned in his e-journal:

> I use the e-dictionary Dr. eye while reading papers and books. It is really convenient. The e-dictionary does not require Internet connection. Its responses are faster than the web-based dictionary, and I don't need to bring a 'real dictionary' to the university everyday. (Evan).

Moreover, e-books such as novels were downloaded for reading or listening anytime, anywhere. Sally noted in her e-journal that she tried to download a novel to the handheld device. She found that the e-book was automatically saved chapter by chapter, which made it convenient for reading. She reported in an interview that she was exposed to varied writing styles through e-books that were beneficial for her to improve her writing skills. Also, with the help of CE-star Chinese software, Sally learned to write some traditional characters, which were new to her as she had learned only simplified Chinese characters when she was in Mainland China.

Multimedia collection – Perceived possible uses of the handheld device for collecting data such as audio, pictorial, text data in varied contexts for learning support using the Camera function, Notes function, and Recording function on the handheld device.

One student Andy considered the recording function most useful. He used the handheld device to record tutorial lectures for later review. At the very beginning, he used the recording software of the device for recording lectures but found that the quality was not good. So he visited an online forum on mobile devices and was recommended recording software. He downloaded this software and did the recordings.

Students also used the camera on the handheld device to collect useful information. Evan reported in his e-journal:

> I used the handheld device to take a photo from the book "Kuby Immunology" in the main library. Thanks to the camera function, I can take a picture of any diagram or graph instead of drawing it on my notebook, or making a paper photocopy. It saves paper and is environmental friendly. The 2.0 Mega Pixel is enough to take a clear picture of any diagram in the book (Refer to Figure 1). (Evan).

Another student Andy noted in his e-journal:

> In a lab experiment, we were asked to work in groups to make a product model, and finished products. In my group, after we finished the work, I used the camera to take the pictures of the model and the final products, and then "infrared" them to my group members to share the experiment results as a reference for writing the lab report later (See Figures 2 and 3). (Andy).
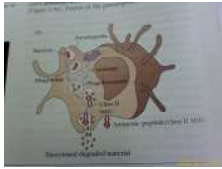
Figure 1. Screenshot of the picture taken by the camera

Figure 2. Screenshot of a product model (Andy)

Figure 3. Screenshot of a finished product (Andy)

Such handheld uses provided the possibilities for Andy and other group members to do comparison and reflection of the lab results when they wrote lab reports later. Also, students often used the notes function of the handheld device to take notes. Ann reported in an interview:

> My teacher often asked us to look up the meaning of words in medicine he wrote on the blackboard. I wrote them straight onto the PDA and was then able to quickly look up the meaning of these terms after class. If I wrote them on a piece of paper, I might lose it and I would not have been able to get such a quick description of their meaning. (Ann).

Multimedia access – Perceived possible uses of the handheld device for getting access to information via the Internet, listening to downloaded audio materials and watching videos for learning support.

Students reported to have used the handheld device to browse the Internet when free internet access was available. These uses included checking course results, exercise answers, emails, reading the latest news, listening to English audio materials, etc. online. Evan noted in his e-journal:

> The handheld device allows me to catch up with the latest news around the world. It makes me keep in close contact with what is happening in the world. (See Figure 4) (Evan).

Sally reported that connecting the handheld device to the Internet using WiFi on campus, she often listened to English programs online during breaks and read BBC news (See Figure 5) to improve her English. In addition, with this device, students could listen to downloaded learning materials, and watch videos that were useful for their study. Sally reported that in one semester, she chose a course 'Special topics in journalism: Documentary'. She had to watch different documentary films to compare and contrast their features to do the assignment. She downloaded and saved some video films in the device, and watched them when she was commuting or taking a break. She reported in an interview:

> I could make small chunks of time to watch the documentary films from time to time, and made reflections afterwards. This enhanced my understanding of the films, and also helped me do the assignment better.

Social interaction – Perceived possible uses of the handheld device for communication via varied channels such as SMS, phone calls, emails, and MSN.

Students stated that SMS and MSN were very useful for sending or receiving short messages or synchronous communication when making phone calls were not convenient or appropriate. Messaging using SMS were usually concerned with alerting friends or classmates for certain functions or activities. However, they considered that SMS alert concerning the status of the books borrowed from the university library was very useful for them. They did not have to worry about when the books were due anymore. MSN was used for chatting most of the time. However, it was often used for exchanging views on certain subjects, or solving problems during the examination period. Students also reported that they felt the handheld device provided increased chances for them to get access to constantly updated emails. It was more convenient and efficient in making good use of lots of small bits of free time than before. One student stated in an interview:

> With this handheld device, I can check emails anytime, anywhere as long as I have a break. If I didn't have this handheld device, I would rather not to do this. Because I have to turn on and off the laptop, or log in and off the desktop in order to check emails, and that takes time, whereas, the device turn-on and use is instant. (Sally).

Students reported that voice communication via phone calls was one of the most frequently used handheld features. To them, making phone calls was considered more convenient for better communication in some situations (e.g., Andy and Sam). They made phone calls usually to classmates or friends for various purposes, such as solving problems and asking questions for certain subjects, especially during the examination period. One student said in an interview:

Sometimes I made phone calls to my friends based in another university asking them some questions concerning a past paper, as they could provide some hints for me to think about. It is easier and faster for me to understand what they said compared to other means of communication. (Andy).

Managing - Perceived possible uses of the handheld device for managing schedules, contacts or financial matters. The function of Contacts was appreciated by students. One student noted in his e-journal:

The Contacts function of this handheld device allows me to input details, even email addresses of my friends. It's much more convenient than that of a mobile phone I used before. It also links to my desktop computer, allowing me to keep a single updated contact list. (Sam).

Some students used Excel or downloaded finance software to manage their own spending or schedules for various functions they were going to participate in.

Data processing - Perceived possible uses of the handheld device for processing documents such as assignments, news report or diaries using Mobile Microsoft Word.

Some students reported that they edited their assignments on the handheld device (See Figure 6). Also Sally explored important use of Mobile Microsoft Word on the handheld device when she worked for China Central TV (CCTV) Hong Kong during her two-month summer internship. She noted in an interview:

When we prepared breaking news reports during an on-the-spot interview, both written language and pictures were used. While the other editors were doing the picture shooting and cutting, I could edit the news report using this handheld device, and asked my teacher to comment on it immediately after I finished the writing. The handheld device improved my efficiency in news reporting (See Figure 7). (Sally).
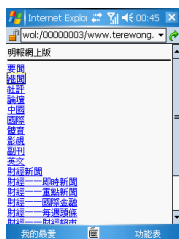
Figure 4. Screenshot of
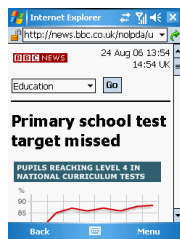
Figure 5. Screenshot of BBC News Report (Sally)

Figure 6. Screenshot of an edited assignment (Evan)

Figure7. Screenshot of an edited news report (Sally)

Connectivity – Perceived possible uses of the handheld device for file sharing and printing by connecting the handheld device with other handheld devices or printers.

Students exchanged files with peers by connecting the handheld device with others' via Bluetooth in order to work collaboratively and communicate more efficiently. They found that exchanging files using Bluetooth among the handheld devices was faster than that using infrared function, especially when the file size was big. Andy also explored the possibility of connecting his device with a laser printer for printing his lab reports. He noted in his e-journal:

I had two months training during summer internship to do experiments in the lab and write-up lab reports. Today, we were asked to submit a lab report, but the printer in the lab was out of order. I copied the file in the SD card and put it in my handheld device because I did not bring my laptop.. I found a laser printer with an infrared function in my faculty. I tried to connect the device with the laser printer but initially encountered difficulties. Finally, I solved the problem by using the PDF file instead of the Word file as the handheld device could not transmit Word files to the laser printer. I was really excited by this 'discovery' and use of my device. (Andy).

Representation – Perceived possible uses of the handheld device for representing complicated concepts in Notes or via graphic software.

Andy reported using the handheld device to help other students to solve problems in time by using the function of Notes in his e-journal (See Figure 8):

On one occasion, my classmate asked me about the microstructure of a metal. As I had no paper on hand at that moment, I used my handheld device to draw the structure immediately to help him solve the problem. (Andy).

Majoring in Mechanical Engineering, Andy had to learn triple integration of the data relationships in Pure Maths. As understanding the triple relationships was difficult by looking at the statistics, he downloaded specialized calculator software, and used it to show the triple integration (See Figure 9). This helped him visualize the data relationships better.
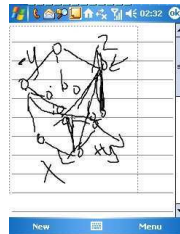
Figure 8. Screenshot of the drawing of a metal microstructure
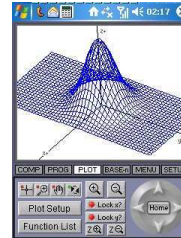
Figure 9. Screenshot of the drawing of a triple integration

It should be noted that any one affordance can be considered to "have both positive and negative connotations" (Conole & Dyke, 2004, p. 113). Students in this study encountered a host of constraints of handheld devices such as small screen size, problems of multimedia access, difficulties associated with inputting data, short battery life, low ring volume, lack of backlight, system breakdowns, etc. These constraints will be elaborated in later papers.

DISCUSSIONS AND CONCLUSIONS

This research study allowed students broad degrees of freedom to use handheld devices for educational purposes. Nine educational affordances of the handheld device were perceived and used by the students taking advantage of the unique characteristics of handheld portability and ease of use. They are summarized as *revision, reference, multimedia collection, multimedia access, connectivity; managing, social interaction; data processing*, and *representation*. Three of these affordances: *multimedia access, connectivity* and *representation* have been identified in an empirical study (Churchill & Churchill, in press). Handheld devices can be used as a reference tool, a multimedia/data collection tool, and a managing tool and this has been discussed in various research studies (e.g., Corlett, Sharples, Bull, & Chan, 2005; Lai et al., 2007).

The last three affordances: *social interaction; data processing*, and *representation* have not been fully explored, and are worth further study. Different means of social interactions via voice communication, emails and messaging afford different possibilities for educational purposes?. For example, communication via email using the handheld device is written, and can be either long or short; communication via SMS is limited to certain numbers of letters or words; and communication via phone calls is achieved verbally. These different forms of communication offer different potential uses for educational practices. Voice communication via a phone call was reported to be used most frequently by students. The major use of the phone calls were to communicate and solve problems in Hong Kong and these may be due to the fact that the number of subscribers of handheld devices in Hong Kong has a penetration rate of about 119.1 percent – one of the highest in the world (www.info.gov.hk/info/hkbrief/eng/living3.htm#communications). This provides a solid basis for using voice communication via the handheld device to support educational practices in Hong Kong. However, handheld devices are often considered a disruptive technology for classroom learning, and research studies involved in handheld phone calls have rarely been reported in the educational research literature. This does not mean that communication via phone calls has no educational value. It was reported that mobile devices were used in a mobile communication system to improve the efficiency of medical practice (Hanada, Fujiki, Nakakuni, & Sullivan, 2006). Possible uses of the handheld device as a voice communication tool, under certain controlled systems or strategic rules, can be developed in the future to deliver synchronous anytime, anywhere learning packages. For instance, in oral English language learning, learners may be provided the opportunities to chat with English teachers or foreign friends from all over the world, given the low cost of phone calls in Hong Kong. Proper use of email communication has been reported helpful for supporting learning through shared information and discussion, and to enrich learning experiences (e.g., Hassini, 2006). With further development of technology, handheld

Internet free access using WiFi is anticipated. It is expected that emailing using handheld devices will play a more important role in education for immediate needs.

Moreover, handheld devices can be used to supplement desktop or laptop computers to process data such as Word files or Excel files. Due to the limitation of the small screen size of handheld devices, editing and processing files using handheld devices is not as efficient as that using desktop or laptop computers. However, this data processing affordance does provide opportunities for students to carry out immediate tasks when other devices are not available. Finally, the handheld device can be used to represent one's ideas and understandings using sketches or graphics, or simply in word files. This has been identified as one of the key roles that technology plays for experiential valued learning (Jonassen, Howland, Moore, & Marra, 2003). In investigating educational affordances of PDA based on a technical education teacher's explorative uses, Churchill and Churchill (in press) also reported that PDAs can be used as a representational tool. However, their interpretation of such a tool use refers to created representations such as mind maps or captured or edited images. Nevertheless, the handheld device as a representation tool can offer many possibilities for supporting knowledge construction in learning.

Finally, it seems that all the participants explored and utilised similar affordances of the handheld device for learning, though the background of the participants are largely different in terms of disciplinary studies and community culture. However, as we probe further, it is noted that the same affordances identified by the participants were perceived and used in varied contexts. According to Gibson's concept of affordances (Gibson, 1979), affordances are the properties of both the environment and the observer. The same environment perceived by different observers may produce different affordances due to the capabilities of the observer. For example, all participants took the device as a reference tool. Some students used the device to look up downloaded dictionaries; some used the device to read e-books, etc. Therefore, how the educational affordances are perceived and used depends on specific contexts in which handheld practices occur. In addition, perception of affordances, to some extent, is determined by the observer's culture, social setting, experience and intentions (Van Lier, 2004). In this study, participants are from different disciplinary studies. Different faculties provide different facilities and resources for students, and have different requirements for students. This means that the learning contexts of the participants are basically different. Also their cultural background and experience varies. Sally comes from Mainland China, and has no experience of using a PDA before; the rest of the participants are Hong Kong local residents. This indicates that handheld uses for learning in specific settings should not be studied in isolation from the broader institutional cultural context in which it is embedded. To put it another way, context emerges from the weaving together of varied elements (Nicolopoulou & Cole, 1993).

In summary, these educational affordances of the handheld device identified in this research are the results of student exploration and use of the possibilities that the handheld device can offer to support their educational practices based on their own experiences. These possible uses are not necessarily unique to handheld devices only. A desktop or laptop computer may perform better than handheld devices in terms of some of the functions found in this research. Currently even voice communication can be achieved through synchronous online chat using a desktop or laptop. However, affordances of handheld devices cannot be put into cause-and-effect descriptors without considering the environment in which they are used (Laurillard et al., 2000). Affordances of handheld devices are context-based (van Lier, 2004). Brown and Randell (2004) argue, "we should think more closely ourselves about context, rather than expecting computers to be able to do this thinking for us" (p. 330). In the meantime, the handheld users should be taken into consideration as different users may detect different affordances for their own educational practices.

IMPLICATIONS
To date, handheld technologies have been woven into our lives. We are "dwelling with technology" (Brown & Randell, 2004, p. 337). That is to say, the handheld use becomes part of our everyday life. It not only "changes how we do things, but also has an ongoing engagement with our life" (Brown & Randell, 2004, p. 337). Therefore, it is crucial to explore the possibilities that handheld devices can offer for educational practices from the perspectives of students. This research study is preliminary due to the small number of students involved and the results cannot be generalized.. Nevertheless, the educational affordances of the handheld device explored in this research will shed some light on what uses students prefer at this point in time, and how students tend to use handheld devices for their practices. This will help researchers and teachers acknowledge that educational affordances of handheld devices vary from situation to situation, and from student to student.

Ongoing handheld education research work should continue to study educational affordances of handheld devices in different contexts using different age groups and on a larger scale. On the one hand, affordances of handheld devices cannot be studied without considering immediate contexts in which handheld uses occur. In specific contexts, despite the handheld device itself, different components such as other technologies or people involved should also be taken into consideration (Song & Fox, 2007). On the other hand, the context in which a specific handheld educational use is embedded is inseparable from other contexts such as institution, family, individual differences (e.g., Lund, 2006). Therefore, *context should be considered from multiple dimensions*. However, few previous research studies in handheld educational applications have addressed such an issue. This may be a future research endeavor.

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AN EVALUATION OF MYARTSPACE: A MOBILE LEARNING SERVICE FOR SCHOOL MUSEUM TRIPS

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ABSTRACT

We report the main findings of the final evaluation study of the MyArtSpace project. MyArtSpace is a combined mobile phone and web-based service to support learning between schools and museums. On arriving for a museum visit the children are loaned mobile phones running the MyArtSpace software. They can view multimedia presentations of museum exhibits, take photos, make voice recordings, write notes and see who else has viewed the exhibit. After each action, the content is automatically transmitted over the phone connection to a website which stores a personal record of their visit. Back in the classroom they can review their visit and the media they have collected, share material with other children and create presentations. MyArtSpace has been deployed in three museums for a year-long trial during which over 3000 school students used the service, on organised visits from local schools. The final user study took place in one museum during November 2006, with a group of twenty-three students aged 11-14 and their teachers. It covered usability, educational and organisational issues, through focus groups, observational studies, questionnaire surveys, and face to face, telephone and email interviews. The study showed that MyArtSpace had a positive impact on school museum visits, and identified areas for improvement in the technical and educational aspects of the service.

Author Keywords
Museum learning, evaluation, multimedia phones, school visits.

INTRODUCTION

MyArtSpace is a service to support learning on school visits. It addresses the problem that a school visit to a museum, gallery, or heritage centre is often isolated from classroom work. The learning objectives are not set out in advance, the teachers have little control over what their students will do during the visit, the students rush through the museum filling in worksheets, and there is little or no follow-up work back in the classroom. Guisasola, Morentin and Zuza (2005) suggest that, to be effective, museum visits should be guided by three principles: (a) Integrating school learning into museum learning; (b) Guiding students towards development and contrasting of their own ideas; (c) Facilitating strategies that are appropriate to the museum's context (op. cit., p. 545). A difficulty in following these principles is that museums are also places for learning by exploration, so guiding students in a pack defeats the aim of allowing them to engage with authentic artefacts and discover their own responses to the exhibits.

The MyArtSpace service aims to connect and guide learning between the classroom and museum, while allowing students to create their own interpretations of the visit through active enquiry. The service was developed by a multimedia company, TheSEA, through discussion and iterative design involving teachers, education advisors, museum curators and software designers. It builds on previous work in the design of mobile technology to support museum visits, including the Bletchley Park/CIPHER Project developed by the Open University, UK (Mulholland et al., 2005), ArtScape at the Peabody Essex Museum MA, USA (Johnson, 2004), Electronic Guides at the Exploratorium, San Francisco, USA (Fleck et al., 2002) and DiGiT at the Dulwich Picture Gallery, UK (Dulwich Picture Gallery, 2004).

MyArtSpace was deployed in three sites: the D-Day Museum (a museum in Portsmouth that interprets the Allied landings during World War 2), Urbis (a museum of urban life in Manchester) and the Study Gallery (an arts centre in Poole). Throughout a year-long trial between February 2006 and January 2007 over 3000 school students used the service, on organised visits from local schools. The authors of this paper were recruited to carry out a lifecycle evaluation of the service, which involved both intervention in the design process, to critique early designs and propose improvements, and also assessments of the usability and educational effectiveness of the service in use.

A previous paper by the authors (Vavoula et al., 2006) has outlined the lifecycle evaluation approach and described a case study evaluation of MyArtSpace in use at the D-Day Museum. In this paper we report the final evaluation of the project, at the conclusion of the year-long trial.

Brief Description of MyArtSpace

MyArtSpace connects a web-based client that can be accessed on a desktop computer in classrooms or homes with software running on mobile phones in the museums and gallery. A typical museum or gallery visit would run as follows.

In the classroom, the teacher discusses the forthcoming museum visit, making use of a printed Teacher's Pack provided by the museum. Typically, the teacher will set one or more questions or goals to guide the visit (such as "Were the D-Day landings a success or failure?", or "What was the role of women in the Allied landings").

On arriving at the museum the students are divided into pairs or groups of three and each person is handed a Nokia 6680 multimedia mobile phone, pre-programmed with the MyArtSpace software (a Java application running on the mobile phone). The phone powers up to a MyArtSpace screen (Figure 1), so they do not have access to the normal phone functions. Each pair uses the phone keypad to type in a unique identifier that identifies them to the service.

Figure 1a Initial screen   Figure 1b Menu of functions

As they tour the museum, each pair of students can 'collect' an object by typing in a two-letter code shown on a printed card beside the exhibit. The phone screen shows an image of the object for confirmation (Figure 2a). This starts a multimedia presentation on the phone, using audio and images to describe the museum exhibit. After collection, they are shown a "did you know" screen that offers some extra background information (Figure 2b). They are then prompted to type in their reasons for choosing that object and are shown a list of who else has collected it.

Figure 2a. Confirmation screen   Figure 2b. 'Did you know?' screen

As well as accessing pre-prepared information in context, they can create their own interpretation of the museum, in relation to their goals. They can take photos with the phone's camera, record audio commentaries, and take notes. At any point they can see a summary list of what they have collected and created. After each action, the content is automatically transmitted over the GSM phone connection to the MyArtSpace website, which builds a personal record of their visit.

Back in the classroom, or at home, the children can log into the MyArtSpace website using their unique identifier. There, they see a 'store' of the objects they have collected or created (Figure 3), and can add new ones by creating them (for example by recording a commentary) or copying them from online stores provided by their peers, their teacher, or the gallery.
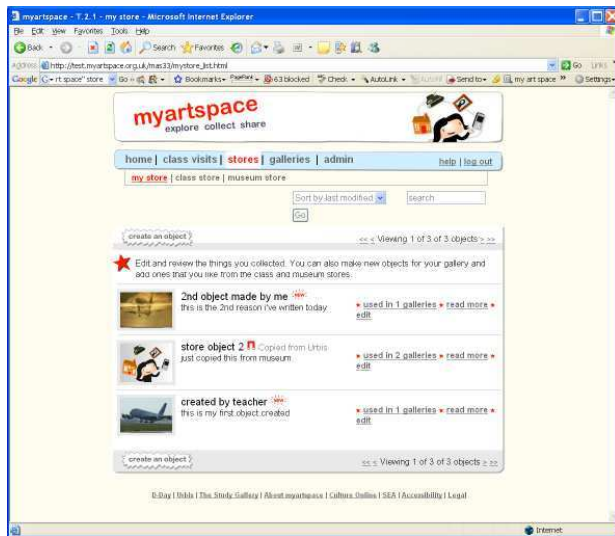
Figure 3. 'Store' of objects collected or created by the students.

Then, they organise the stores into online 'galleries' which are similar to presentations, using a tool like a simplified PowerPoint presentation manager. Figure 4 shows one frame from the online gallery, with a photo taken by a student along with a written caption. The teacher acts as moderator of the content and can opt to publish student's 'gallery' presentation on the web so that it can be seen by other schools, parents, and the general public.
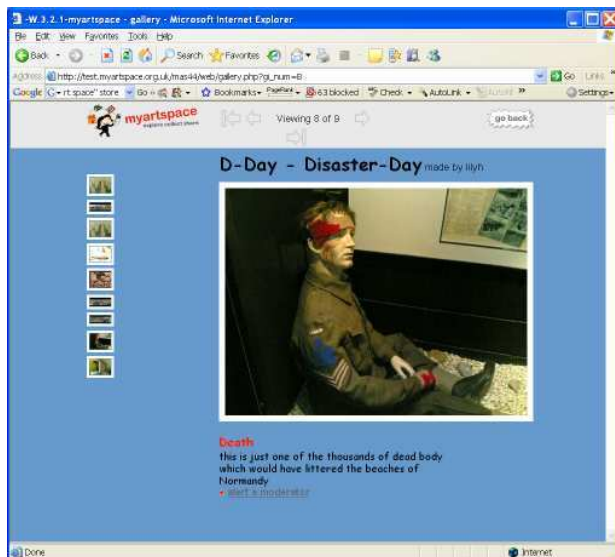
Figure 4. Frame from the online 'gallery'.

FINAL EVALUATION OF MYARTSPACE

Method
The final user study took place in November 2006 in relation to the D-Day museum, with a group of twenty-three KeyStage 3 (age 11-14) students and their teachers. The main evaluation aims for this study were to:
–   assess the educational value of MyArtSpace;
–   ascertain whether the service meets the ISO 9241 standards of usability;
–   assess whether issues highlighted in earlier evaluations had been addressed.

The evaluation illuminated the use of the service by teachers, students and museum staff at three levels of granularity: Micro (usability issues), Meso (educational issues), and Macro (organisational issues), see Table 1. At each level, a three-step analysis was carried out:

Step 1. What was supposed to happen. Pre-interviews with stakeholders (teachers, students, museum educators), documents provided to teachers to support the visits.

Step 2. What actually happened. Observer logs, post-focus groups, analysis of video diary.

Step 3. Differences between 1 & 2. Reflective interviews with stakeholders, critical incident analysis.

Micro level: Usability issues	Meso level: Educational Issues	Macro level: Organisational Issues
Technology usability Individual and group activities	Learning experience as a whole Classroom-museum-home continuity Critical incidents: learning breakthroughs and breakdowns	Effect on the educational practice for school museum visits Emergence of new practices take-up and sustainability

Table 1. Framework for the evaluation

The data collection methods were as follows:

One-to-one interviews. These were conducted with the teacher prior to the study, following the initial lesson, following the museum visit and following the post visit lesson.

Focus groups. The teacher selected two groups of students (a group of three girls and a group of three boys) to be interviewed following the pre-visit lesson, museum visit and post visit lesson.

Observations. The students and teacher were observed during the pre-visit lesson, museum visit and post visit lesson. During the museum visit DVD recordings were made of two groups as they worked their way around the museum. Critical incidents in the DVD of their visit were shown to students during post-visit focus groups to enable them to reflect on their use of MyArtSpace.

Questionnaires. These were distributed to students following the pre-visit lesson, museum visit and post visit lesson.

Telephone / Email interviews. These were conducted with representatives from TheSEA, the project sponsors, and the participating museums.

The data collected by these methods were analysed by the project team to identify critical incidents that indicate either breakthroughs (evidence of successful learning activities and outcomes) and breakdowns (evidence of failures in the interaction between the students and the technology, or failures to take advantage of the learning opportunities within or between the sites. Where a critical incident was identified, it was explored in the interviews and focus groups to see if it was indicative of a more general success or problem.

Overview of the study

The MyArtSpace experience for the school students who participated in the study involved three lessons. A previsit lesson took place at school on the Friday before the museum visit. During the lesson the teacher introduced the topic of D-Day to students. The teacher had prepared worksheets that students would work on in the museum. Each worksheet dealt with a D-Day issue (e.g. 'life at the home front') and contained a number of associated questions.

The museum visit took place on the following Monday. Students arrived at the museum with their worksheets and login details. The museum Education Officer gave them an introduction to MyArtSpace, explaining how the phones worked and what they could do with them. Students were told to explore the museum in groups and collect items relevant to the questions on the topic in their worksheet.

The post-visit lesson took place on the next day. Students worked individually for the post-visit lesson to create their galleries. The teacher and the classroom assistant walked round the room helping students. Evaluation activities took place before, during and after each lesson. The teacher suggested two student groups, one group of three girls and one group of three boys, who would be the 'focus' groups. These two groups were interviewed after each lesson, and were followed closely in the museum. The footage from the girls' museum tour was edited before the post-visit lesson to create a video-diary of interesting

incidents from the group's tour in the museum. The girls' group was then shown that diary in the interview following the post-visit lesson and were asked to clarify the incidents. In addition, questionnaires were distributed to the whole class after each lesson. The teacher was interviewed before and after all three lessons.

Summary of results

MyArtSpace had a positive impact on school museum visits from the perspective of the teacher and students, compared to previous museum visits that had not used the service. Feedback from museum representatives regarding the day-to-day running of the service suggested similar benefits. The study also identified a number of areas in the design of the MyArtSpace experience at the technological and educational levels that need further refinement to enhance the benefits. The advantages of MyArtSpace and the areas that can be improved are summarised below together with related recommendations.

Advantages of MyArtSpace

The form factor of the devices was appropriate. One of the students in this study remarked that they liked the fact that the device was actually a mobile phone and not a typical handheld museum guide. Mobile phones are commonly owned by students in this age group.

Collecting and creating items was an easy and natural process. The students generally found no problems in operating the phone and, providing it was within range of a signal, the content was sent seamlessly to the website.

The service met students' and teachers' expectations. All teachers and students in the trials reported positive impressions of MyArtSpace. In summary, teachers reported that their students engaged more with the exhibits than in previous visits and had the chance to do meaningful follow-up work. Students reported that they enjoyed their visit and that they found it more interesting and fun than traditional visits.

The activity supports curriculum topics in literacy and media studies. In addition to supporting curriculum topics related to the museum displays, MyArtSpace encourages children to make informed decisions about the content and viewpoint of their collections, to combine text and visual media, and to create reflective multimedia presentations.

It encourages meaningful and enjoyable pre- and post-visit lessons. Pre- and post-visit lessons are not standard practice for many teachers/schools. The teachers in the trials commented on the way MyArtSpace offers an easy route to the planning of pre and post-visit lessons which are enjoyable for the students.

Students spent longer exploring the museum. According to the Museum Education Officer, the average length of time a student spent exploring the museum increased from 20 minutes for a conventional school visit, to 90 minutes with MyArtSpace. Although some of this time included operating the equipment, it was clear from our observations that this mostly involved activity related to the educational task, such as framing a photograph, rather than the technology.

Students engaged with the museum. Observations of MyArtSpace in use showed students working with exhibits and asking questions such as 'why do we want to collect this?', deconstructing objects, and reflecting on their relevance to the learning task.

It supports students of differing abilities. A teacher at the Urbis site noted that the lower ability students used the camera to capture their experiences as they walked round, whereas higher ability students engaged with a map of the site to plan where to collect and create material. These appear to match the cognitive processes proposed by Scardamalia and Bereiter of *knowledge telling*, where a simple linear sequence of actions invokes further, related, actions and *knowledge transforming*, where a learner explicitly explores goals, content and structure to solve a problem (Scardamalia & Bereiter, 1987).

Museum appeal is enhanced. Many students and teachers commented that they would visit the museum again and said they would recommend it to others.

It bridges the gap between museums and classrooms. MyArtSpace was successful at bridging the museum-classroom gap by facilitating the teacher's design of pre and post-visit lessons, enabling students to create artefacts in the museum and have them readily available for further work in the classroom, and extending the museum context into the classroom through the online museum stores.

Student motivation was enhanced. Students in the trials appreciated the use of modern, 'cutting edge' technology and teachers have remarked on how enjoyable the experience was for students.

Limitations of MyArtSpace and areas for improvement

There were usability problems. Usability problems included confusion between standard uses of buttons on the mobile phone, and the uses for the MyArtSpace application. Thus, the use of the Nokia 'Clear' button was used as a 'Cancel' button in text entry fields, which led to frustration and confusion over whether an item had been collected, resulting in duplicate items.

The phone connection sometimes failed. Inside the museum the phone connection was unreliable, which sometimes resulted in the system failing and the phones needing to be reset.

The phones rapidly became outmoded. During early evaluations, in November 2005, some students described the phones as 'cool'. During the final evaluation, in November 2006, students were less impressed with the devices and asked for features that are now standard on consumer phones, such as a video recording facility.

There was a lack of teacher orientation. Most teachers did not attend the museum for an introduction to the service prior to using it with their classes and the information in the Teacher's Pack did not include a section on how MyArtSpace works. Many teachers first used the MyArtSpace web site without any background knowledge on what it was about or how it worked.

Student orientation was poor. Most classes did not use the MyArtSpace website during the pre-visit lesson. At best the teacher would demonstrate an example gallery; at worse the students would know nothing about the desktop web software until after their museum tour. Students thus went to the museum knowing in theory what MyArtSpace would enable them to do, but not the specifics.

A quick reference guide was needed. Teachers, students and museum representatives have expressed a need for a quick reference guide, in the form of a 'how to' set of instructions.

The post-visit activity can be time consuming. For the class we observed, one post-visit lesson was not sufficient for students to finish their galleries, so another lesson was scheduled. In part, this was because the students were using unfamiliar software, but also because they were engaged in the productive activities of sifting evidence and creating a coherent presentation.

Students had problems in organising images and sounds out of context. Some students found difficulty in identifying pictures and sounds they had recorded. This indicates a more general problem of re-creating the context of the museum visit back in the classroom. The time-ordered list of objects list of objects they had collected provided some cues, but there needs to be a facility to link objects, photos and sounds at the museum to create a richer, more contextual object.

The more items are collected, the harder it was to organise them. The more that students engaged with the museum visit, collecting items and creating content, the more difficult it was to organise the material back in the classroom. There is a difficult trade-off between constraining the museum visit to make it easier to manage the material (for example by limiting the number of items that can be collected) and stifling creativity and engagement.

The tools for group awareness were not effective. The facility to find who else has collected an item (and thus compare experiences with them) was seldom used. However, this is not necessarily a problem. The students generally worked well in groups of two or three, planning how to take a photo or discussing a note, and there may be little to gain from further collaboration inside the museum. However, tools could be added to support collaborative project work back in the classroom.

The service is costly. Museum representatives have expressed concerns about the running costs of the service, including staff time and resources. Many museums already provide audio guides for museum visitors, and MyArtSpace is yet another service for the museum to manage.

CONCLUSIONS

MyArtSpace is different from other multimedia museum guides. It connects the museum visit to the classroom and to the student's homes, so that the visit becomes part of a sequence of planning, engagement, and reflection. The pre- and post-museum visit lessons extended the museum visit into the classroom and enabled the students to reflect reflected on their experience. The alternative educational service for student visits to the museum is paper-based worksheets, which a teacher has described as "passive". In contrast, a student described the experience with MyArtSpace at the museum as "less boring, more modern".

The opportunity to carry out an evaluation throughout the project lifecycle has provided insights into the design and deployment of a mobile learning service. The way a system like MyArtSpace is used cannot be determined until it is actually used by real people in real settings. The continuous evaluation and fine-tuning of the new technology in concert with the learning practice (including lesson planning, IT support, and activity planning) resulted in a system that met the initial design aims and provided a generally reliable service to museums. The study also identified issues that will need to be addressed in future

services for museum or field trips, including the need to orient teachers and students to the experience, how to re-create the context of the visit back in the classroom, and finding a suitable business model for museums and schools to support a continued service.

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A STUDY ON THE ACCEPTANCE OF MOBILE PHONES FOR TEACHING AND LEARNING WITH PRE SERVICE TEACHERS

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ABSTRACT

In this study, a group of pre-service IT teachers in Hong Kong were introduced to the field of m-Learning by participating in a series of m-Learning activities. The research aimed at providing the opportunities for the teachers to explore this new trend in teaching and learning and to find out their acceptance of this approach.

INTRODUCTION

The emergence of mobile and wireless technologies is already impacting teaching and learning. New Internet technologies are being used to support small-screen mobile and wireless devices. In a field marked by such rapid evolution, we cannot assume that the Web is the sole medium for computer-based learning. The combination of mobile and Web-based technologies opens a new horizon for educators. The use of portable devices for teaching and learning is increasingly popular in education.

In this research, a study of mobile learning was conducted for a group of pre-service teachers in Hong Kong. To investigate the innovative practice and the acceptance of mobile phones in teaching and learning, a set of m-learning activities were developed. Three activities were being carried out. A questionnaire was used to collect the data at the end of the activities. Data are analyzed and findings are then reported in this paper.

FOCUS OF THE STUDY

The focus of this study is to find out the acceptance of mobile phones for teaching and learning by my students (the research question). This may link heavily to their daily operational use of mobile phones. In general, there are three dimensions that are critically affecting the success of m-Learning as illustrated in Figure 1. Among the three dimensions, mobile phones have greater advantages in term of "location independence". Mobile phones make it possible to gather and record information nearly everywhere. They have the highest mobility inside or outside classrooms. The coverage of mobile phones allows teachers to engage in activities requiring ubiquitous tools. With respect to the dimension of "time independence", mobile phones can also be used in asynchronous and synchronous learning. SMS and forum messages can be retrieved and sent to support asynchronous learning. Synchronous learning can be facilitated via in-class voting systems and interactive games on mobile phones. They can also be used as real-time assessment tools. The dimension of "meaningful content" is the most critical one. Without quality content, m-Learning will be meaningless. There are many factors adversely affecting the delivery of quality content using mobile phones. Slow processing speed, limited bandwidth, small form-factor, limited memory and one-finger operation are some of them.
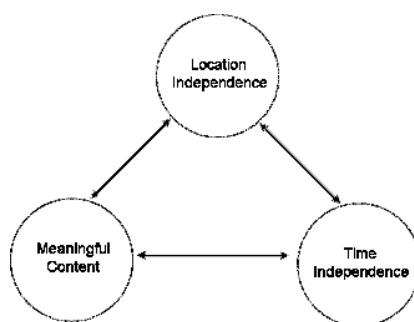
Figure 1. Three important dimensions in m-Learning.

To study the acceptance of mobile phones for teaching and learning, the following three Ws to the research question must be considered:

WHO are the participants in this study? I have a big class in an undergraduate unit called "Network Management in Schools". This group of pre-service teachers could be the better candidates for this research because of their exposure to the networking concepts. Furthermore, they are the young teachers soon be out in the field. They should be given opportunities to explore any innovative idea in

teaching and learning. As it is not appropriate to occupy their regular lessons for this research, an additional lesson at the end of the unit was conducted.

WHAT types of activities should I organize to cover my research question? A mobile phone is nothing more than a limited but featured computer. We must recognize the limitations of these devices and develop what they can do best. A voting system, an interactive game and an assessment platform (i.e. an examination system) were pursued in this study. These activities cover the major directions in m-Learning.

WHERE can I conduct the activities? To minimize the interference to my students, one-off experiment was performed and a questionnaire was used to collect their opinions. It took place in a classroom environment.

METHODOLOGY

In this research, three activities were developed to address different applications of mobile phones for teaching and learning. Simulators developed to execute in real mobile phones are used for this study (Openwave, 2006). There are three reasons for this approach. Firstly, the chosen software has been implemented in a number of real phone models. It behaves like a real phone. Secondly, many students may not have mobile phones with advanced features to support WAP 2.0 (Wapforum, 2006). Some students may still have text-based mobile phones! Thirdly, as long as students operate the simulator (e.g. one-finger operation) as the experiment intended, I have a better controlled environment to answer my research question.

To support the experiment of this research or any m-Learning application in general, a WAP gateway connected to a Web server is needed. Figure 2 outlines the system architecture to support applications over mobile devices. Apache, PHP and MySQL were chosen as the Web server, server-side programming and database support respectively.
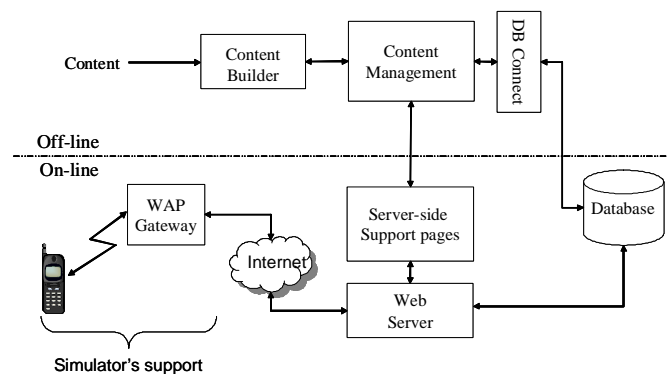
Figure 2. The system architecture to support m-Learning.

Among the three applications developed for this experiment, the first application is a voting system. Students can cast their votes and teachers can interactively check the voting results as shown in Figure 3 and Figure 4. Students can use the quick access keys ("1" to "X") on the keypad to cast their votes. This acts as if the voter has a simple voting machine at hand. Teachers can retrieve the voting results from the database onto their handsets as well.

Figure 3. A voting activity.   *Figure 4. The corresponding voting result.*

The second application is an interactive game called "15/16" which is a popular game in TV recently in Hong Kong. Instead of two players per game, it was modified that the whole class can participate in each game. Students make their selections and the teacher (or any student) suggests the explanation. Students can change their mind depending on whether they believe the teacher / students or not. Figure 5 illustrates two questions. Teachers can show or refresh students' selections at anytime as shown in Figure 6.

Figure 5. Two questions from the "15/16" interactive game.   *Figure 6. Students' selections.*

The third application is a system to administrate tests or examinations. Students attempt the questions stored in the database. The overall score can be sent to the students at the end of the test as shown in Figure 7 and Figure 8. The scores are kept in the database as well.

Figure 7. A test on mobile phones.   *Figure 8. The score.*

The implementations of the "15/16" game on actual Nokia handsets are shown in Figure 9. Students can use the suitable handsets to participate with the applications.
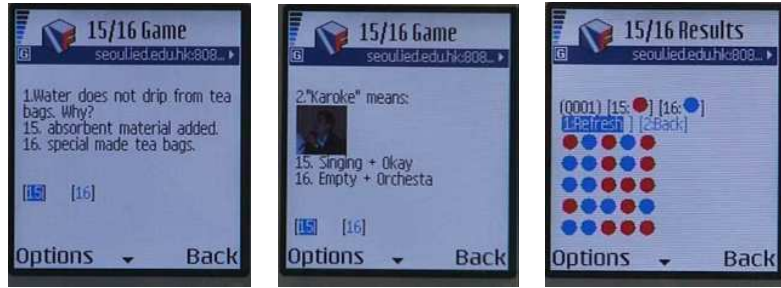
Figure 9. The "15/16" game on Nokia Handsets.

Two main groups of data were collected in this research. The first data set was obtained in real-time from the activities themselves. Figure 10 shows the sample data for the '15/16" game in MySQL.

←┬→	Question	nstudents	student001	student002	student003	student004	student005	student006	studen
☐ ✎✗	2	30	1	1	1	1	1	0	
☐ ✎✗	1	30	0	1	1	0	0	0	
☐ ✎✗	3	30	0	0	1	0	0	0	

Figure 10. Sample data of the "15/16" game.

The second data set was for the questionnaire. The questions could be categorized into the following four areas:

1. Basic information – to establish the background of the students.
2. Handset and service information – to find out the types, the mobile service providers, the tariffs, and services (e.g. 2.5G or 3G).
3. Phone usage and practice – to survey information such as airtime, SMS, MMS, ring-tone download, Internet and other usages.
4. Attitude – to find out how the students feel about the use of mobile phones for teaching and learning.

DATA COLLECTION AND ANALYSIS
A total of twenty-four students completed the three activities and the survey as shown in Figure 11.

Figure 11. Pictures taken during the experiment and the survey.

The data obtained from the questionnaire were keyed into the database for analysis as shown in Figure 12.

←┬→	QN	A1	A2	A3	A4	A5_1	A5_2	A5_3	A6_1	A6_2	A6_3	B1	B2	B3	D1	D2	D3	D4	D5_1	D5_2	D5_3	D5_4	D5_5	D5_6	D6	D7	D8
☐ ✎✗	3	1	2	2	1	2	0	0	6	0	0	Nokia	8012	5	2	2	2	2	0	1	1	0	0		3	3	2
☐ ✎✗	2	2	2	2	1	8	0	0	6	0	0	Nokia	6230●●◖		1	1	1	1	1	1	1	1	1		1	2	2
☐ ✎✗	1	2	2	2	1	4	0	0	6	0	0	Sony Ericsson	K700i	4	2	2	2	3	1	1	0	0	0		3	3	2
☐ ✎✗	6	2	2	2	1	3	0	0	6	0	0	Dopod	818 Pro	6	3	3	3	3	1	1	1	1	1		3	3	3

Figure 12. Data extracted from the questionnaire and stored in MySQL.

1. Demographics:

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The following charts provide a demographic overview of the respondents with respect to age, gender, handset brands and types of mobile services.
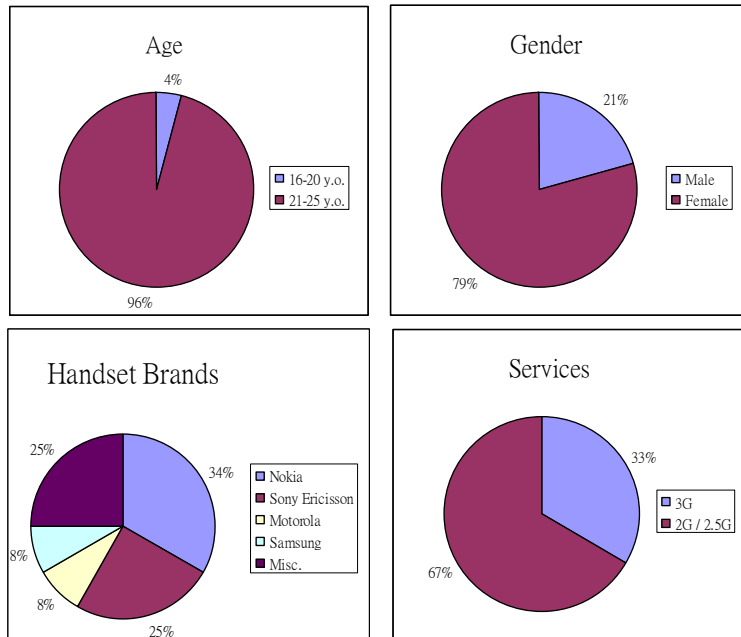
Since the respondents are from a single class of pre-service teachers taking Information Technology as their minor study, their age group is quite close. Also, the distribution of male and female respondents reviews the typical composition of any education programme in the Hong Kong Institute of Education.

With no surprise, Nokia is the leader of the market share on handsets with 34% and followed by Sony Ericisson (25%). About 1/3 of the respondents use 3G services and spend on average HK$107 (from the database) per month with the average air-time plan of 1020 minutes.

2. Usage and practice:

The following charts reveal how the respondents use mobile phones for different purposes. Most of the recent handsets equip with camera, true color display, stereo sound and external memory card. They can be multi-purposes for the students as shown in the data.

SMS Usage

MMS Usage
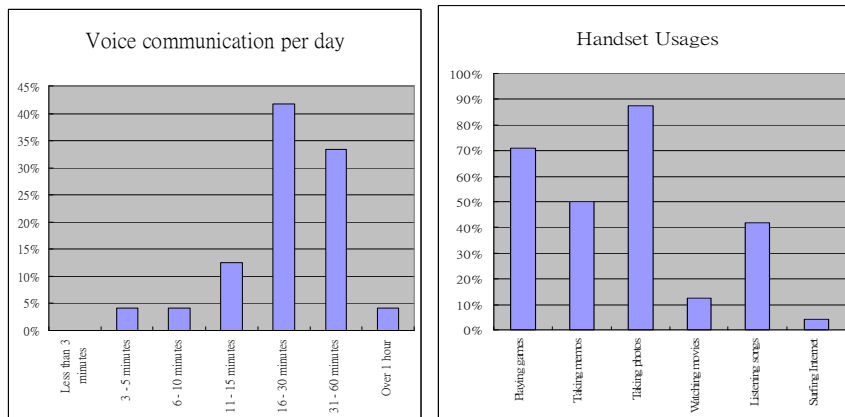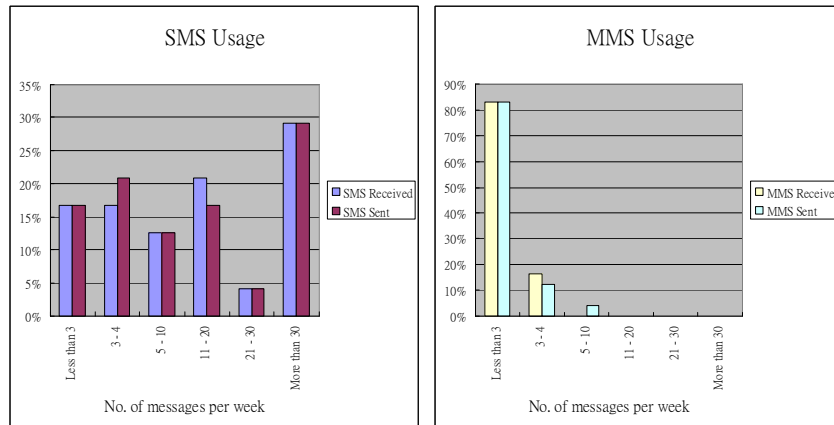
While the majority of them use mobile phones for voice communication (47% of the respondents, on average, talk for 16 – 30 minutes per day), other usages such as taking photos (88%) and playing games (71%) dominate their different practices.

Sending and retrieving SMS messages are quite popular among the respondents, but sending and retrieving MMS messages remain low.

3. Acceptance of mobile phones for teaching and learning:

This section provides answers to the focus of this research. Respondents were asked to express their views on using mobile phones for teaching, learning and administrative purposes. After they have just experienced the activities described above, respondents can state their difficulties. They were also asked to provide their opinions on issues like secondary students taking mobile phones to schools, communicating with parents using SMS messages, and incorporating the topic of "m-Learning" into their curriculum.

Mobile phones can improve the quality of education.

I am interested to use mobile phones as teaching and learning tools.

Mobile phones can be used to assist teaching and learning.

Mobile phones can be effective tools in classrooms and at distance learning.

The difficulty of using mobile phones for teaching and learning

Mobile phones can be used for administrative purposes (e.g. send SMS messages to parents).

Should secondary students bring their mobile phones to schools?

Do you want to see "m-Learning" be part of your curriculum?

This study shows that the majority of the respondents accepted the use of mobile phones for teaching and learning in general. They found the inhibiting factors are small screens (67%), text input (58%), slow connectivity (58%), expensive (46%) and difficult to use (33%).

They somewhat agreed that mobile phones can improve the quality of education (54%). Their curiosity on using mobile phones for teaching and learning is high (67%: 63% + 4%). The respondents have quite a liberal mind on allowing secondary students to bring mobile phones to schools (87%: 79% + 8%). They would like to use mobile phones for administrative purposes (75%: 71% + 4%). They were somewhat interested to see "m-Learning" be part of their curriculum.

DISCUSSIONS

In this study, the focus is to find out the acceptance of mobile phones for teaching and learning by a group of pre-service teachers. The experiment was generally well-received by my students. They found that it is fun to participate in the exercise.

The findings of this study are summarized in the following:

- The respondents agreed that mobile phones can be used for teaching and learning. However, they were somewhat sceptical towards the quality that mobile phones can bring to education.

- The majority of the respondents are very liberal and interested to use mobile phones for teaching and learning.

- With this age group, SMS messaging is a popular way to communicate.

- Mobile phones are mainly used for talking, texting, taking photographs and playing games.

Although the sample size is small and the findings may not be reliable, this study provides me with the preliminary data to carry out more discriminating experiments on m-Learning.

I found the activity such as the "15/16" game is a great way to motivate students and foster interaction among participants. This is not only applicable to the field of m-Learning, but also a general pedagogical technique in teaching and learning.

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MOBILE LEARNING – DESIGNING THE LEARNING CONTEXT

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ABSTRACT

This paper contributes to the conceptualisation of school-based curriculum design processes that incorporate high quality mobile learning and considers the work of a recent m-learning project where classroom teachers embedded use of mobile technology into their working school programs. Project teachers devised a set of principles based on current education theory and practice to inform their curriculum design process. These principles incorporated socio-cultural perspectives of learning coupled with recent research of pedagogical processes that result in high quality learning experiences. Units of classwork written by small teams of classroom teachers interpreted these principles as they applied to their students, school and the local community. Feedback from project participants indicates that the use of mobile technology contributed to sustained levels of student engagement with their learning and work of greater than expected quality.

Author Keywords
Curriculum development, mobile learning, quality teaching and learning, science education, environmental education, pedagogy

INTRODUCTION

Research that informs the practice of mobile learning is available as a growing group of documented case studies of innovative practice (eg Rentoul et al 2003; Klopfer et.al 2002; Zembal-Saul et al 2002). Recent trends evident in the literature reveal a call for both research that embeds mobile learning into classroom practice (Naismith et al 2004) and development of a theory of mobile learning (Sharples et al 2005; Laouris and Eteokleous 2005). The work reported in this paper represents early stages in the exploration of the nature of high quality mobile learning in a school situation. The paper identifies themes and issues emerging from direct experience with designing school-based curriculum that embeds mobile learning and the use of mobile technology into classroom practice.

The project team was inspired by case studies focusing on learning in the local environment from both a Sydney-based primary school (Bennett, 1998) and from the United Kingdom (Rogers et al., 2002). The former project resulted in a database of plants and animals from a local wetland available as a web site for the local community. Project teachers aspired to incorporate processes that would result in a resource of similar availability and use to their local community. The latter project incorporated the use of novel technologies constructed to augment student learning in a local woodland. This model of creative hardware and software development was used to engage undergraduate students who were given the opportunity to choose to develop novel devices or software for a project school.

The mobile technology available to the project included tablet personal computers (tablet pcs). The unique properties of mobile devices that contribute to their effectiveness in education are outlined by Klopfer et al (2002) and include: portability, context sensitivity, connectivity, social interactivity and individuality. The project team intended to utilise these properties to unlock students from desk-bound computers and support their inquiries in learning environments beyond the classroom. It is important to consider that, at the start of the project, none of the classroom teachers involved had seen or interacted with the tablet pcs that would support their students' learning. Close collaboration between project ICT and education specialists became an essential component of its work.

This paper will report on the school-based curriculum development processes of the project. Theoretical underpinning of this work will be identified as well as the process and products of school-based programming. Teachers' reflections on the project highlight their expectations for student learning as well as unintended outcomes of conducting their unit of classwork. Student work samples demonstrate the high quality of learning associated with this approach. The paper identifies emerging themes and issues for further research around the processes of curriculum development for mobile learning described in this work.

CONSIDERING A THEORY OF EDUCATION

The wide application of mobile learning and its growing use in schools, museums and learning in other contexts requires consideration of theory that can inform education practice across these situations. The need to consider a theory of education was expressed by Hein as making an "effort to think through the underlying principles on which we base educational activities" (Hein, 1998, p. 15). He proposed three areas requiring a theoretical stance: the nature of knowledge, a theory proposing how people learn and a theoretical basis for teaching practice. Scholarly deliberations about the nature of knowledge were considered to be beyond the scope of the present project, however the project team adopted the position that knowledge is obtained through active processes occurring within the learner. These active processes require the learner to re-work or to reconstruct understandings and processes they encounter, making sense of new information in the light of previous understandings and experiences (Windschitl, 2002).

The project sought to view students as knowledge communicators where they have access to knowledge and understandings held in their community about the local environment. There was a tacit understanding that students would work with this knowledge and re-present their understandings in a form that then becomes available to their local community. This view of learning as knowledge construction coupled with the project's use of collaborative and consultative processes relates directly to Vygotsky's (1978) social constructivist approaches to learning.

Closely linked with such considerations of learning are those of designing a teaching approach that incorporates an active, learner-centred pedagogy. Over the past decade considerable research has endeavoured to illuminate characteristics of pedagogy that contribute to effective learning for all students. The 'authentic pedagogy' movement (Newmann and Associates, 1996; Newmann, 2000) articulated "three broad criteria for authentic intellectual work:

1. Construction of knowledge: using or manipulating knowledge as in analysis, interpretation, synthesis and evaluation, rather than only reproducing knowledge in previously stated forms.
2. Disciplined inquiry: gaining in-depth understanding of limited topics, rather than superficial acquaintance with many; and using elaborated forms of communication to learn and to express one's conclusions.
3. Value beyond school: the production of discourse, products, and performances that have personal, aesthetic, or social significance beyond demonstration of success to a teacher." (Newmann 2000, p. 2)

Newmann's research has been adapted to an Australian context and articulated for schools in New South Wales (NSW) as the Quality Teaching model (NSW Department of Education and Training 2003a; 2003b). This model "identifies generic qualities of pedagogy that have been successfully applied in a range of school contexts and are shown to lead to improved student learning" (NSWDET, 2003a, p. 5). Inquiry that seeks to describe quality mobile learning can utilise the shared language and understandings of this model to articulate and evaluate the pedagogical aspects of the work.

Project teachers engaged with the theoretical aspirations of the study outlined in this section and used them to form a set of principles to guide both curriculum development and pedagogical approaches for the project. These principles are described in the next section.

DESIGNING THE LEARNING CONTEXT- FROM THE GROUND UP

A framework of common understandings about learning and teaching created by the project team, based on the theoretical considerations outlined in the previous section, is presented in this paper as the following set of guiding principles.

- Students are actively engaged in collaborative, student-directed inquiry.

- This inquiry is significant to both the student and to the wider community.

- The study involves opportunities for substantive communication between students; between students and teachers; between students and other adults including professionals and other community members.

- Knowledge constructed by this inquiry is integrated within and across subject areas and represents a sound contribution to scientific and cultural understanding of a local area.

Once this framework of common understandings was reached, project teachers, working in school-based teams developed their units of classwork that incorporated mobile learning and utilised mobile

technology. The unit of classwork is viewed by the project as the formal plan that provides the learning context that involves student-lead inquiry and generates the need for the use of technology to support the mobile learner. Teachers developed a unit of work that was specific to the needs of their students, relevant to the curriculum of their school and located in the community and local environment of the school. Topics chosen by project schools included investigation of plants in the school grounds, insect diversity in a local park, the journey of a drop of rain after it falls on the school playground and investigation of human impact on the local water catchment area. The units of work, student work samples and teacher reflections for this project can be viewed at http://coco.edfac.usyd.edu.au/mobilelearning

Units of classwork

The units of classwork contain statements about the learning outcomes that teachers want to achieve and the assessment strategies that will indicate the achievement of these outcomes. Conversations between project teachers generated by this approach to programming served a range of purposes including clear articulation of the nature of products that would demonstrate students' learning as well as providing a focus on the nature and scope of activities that could be achieved in a typical teaching term.

The unit plans provide some detail of the sequences of teaching and learning activities and typically commence with student familiarisation with the technology and move on to application of these skills the context of the inquiry. The teaching and learning sequence reveals that students will be engaged in at least two field trips to their local environment. Local naturalists and other adults are also involved both in classwork and with the field trips. There are no details of actual lessons within the sequences – this would have provided further insight into actual strategies teachers have utilised to introduce the unit, to provide motivation for the students, to scaffold student-led activities etc. Group work processes are not detailed within these units and form the subject of a further paper at this conference.

The unit plans provide insight into the affordances provided by mobile technology particularly in the area of supporting mobile learning. These included the following:

- recording data collected in the field

- providing a 'seamless' transfer of data between the classroom and the field

- incorporation of data directly into 'working' inquiry processes

- communication with experts via wireless access to the internet

- sourcing further information from the internet via wireless access.

Tablet pcs proved to be a highly reliable, flexible and effective tool to support this range of learning activities. The portability of the tablet pc saw their use within and beyond the school. It was common to see one or two students take a tablet pc and stretch out on the floor or move to a quiet corner to continue their work. The need for specialised instructions for using the computer itself or its software was minimised by the pc's ease of use and its capacity to support generic rather than specific software. Documents created on different systems were available across each system. The tablet pc supported communication in a variety of learning environments. It was common to see groups of students clustered around the open face of the pc. While further research is required to determine the exact nature of the conversations within this cluster, it was obvious that students were either contributing to the content of the group's records or making suggestions about the use of the computer.

The large area for handwriting on the face of the tablet pc enabled students of all ages to create extensive, permanent and transferable records of their field work. The quality of this digital record surpassed that of a paper record. Indeed many groups of students requested to be able to work directly on documents that in effect moved their level of cognitive processing beyond identification and description to on-the-spot analysis and reporting. Further work is continuing on the development of a location-aware interactive website available within a closed network of pcs. Students are able to upload new records and update continuing records on their site.

The wireless capabilities of the tablet pc were utilised by students when they accessed remote experts who could assist them with expert information such as identification of found species. Once a species name was known, students could access further information by using wireless access to the internet. Access to the internet in the field was achieved initially by the use of a wireless router located in a nearby classroom. The possibility of wider access afforded by an external internet provider is currently

being explored however there are issues relating to the desirability of direct and open internet access available to young students.

Teacher reflections

Project teachers tended to express their expectations of the project in terms of their students having access to special technology and the opportunity to increase their skills in using a range of technologies in a real world situation. Use of tablet pcs and other technologies appears to have been a motivating factor for the students who are reported to have been highly engaged in all tasks associated with the unit of work. Teachers reported that an unexpected element was the level of student engagement, enthusiasm and perseverance from even the youngest students involved in the work. Students not only incorporated the facilities of the new technologies into their learning processes both in the field and in the classroom, they willingly shared new found expertise with their classmates and with their teachers. Two classroom teachers involved with the project made the following observation about the use of technology in their classwork.

> "From both the teachers and students involved this was an exciting project, mainly because it enabled the students to have many meaningful experiences using different forms of technology. Also, they were using the technology to assist their learning in real life situations for a real purpose and not just for the sake of ticking the technology box." (Hosking and Lloyd, 2006)

At the end of the unit of work the project team was able to consider the range of learning outcomes that were achieved by students during the unit. Aside from the formal outcomes described in each unit of classwork, a range of further outcomes were identified in the following areas.

1. Communicating scientifically: a group of outcomes relating to selecting, writing and presenting scientific information for a range of audiences; interacting with knowledgeable adults to elicit, record and communicate information.

2. Researching scientific information: a group of outcomes relating to critical selection and use of scientific references that 'make sense'; recognising and decoding scientific words and terms that are unfamiliar.

3. Working scientifically – in the field: a group of outcomes relating to collecting, organising, storing and retrieving digital records collected in the field.

Further research and professional development is required to consolidate this skill-set that relates specifically to mobile learning.

Student work samples

The digital works produced by the students involved in the project can be viewed at the project website. We will turn our attention to the work of the youngest class (6-8 year olds) and consider their information sheets in the light of the assessment rubric created for this piece of work. The task asked students to use pictures and text on a computer to present scientific information about their species that would be interesting to another student in the school. The following elements were discussed with students as components of their information report: the final product; factual text; digital photograph and scientific communication. Achievement at each of five levels was also made explicit to the students. A grade of 'C' was described as a pass i.e. students were achieving at the level we expected. Students were presented with two grades either side of this pass grade, describing work of higher and of lower achievement. It appears that the young students viewed this set of criteria as something of challenge and opted to aim for the higher gradings.

One of the outstanding features of students' work is their digital photographs. Basic competence in capturing a digital image of their plant was achieved and surpassed by each of the 30 students in the class. Students selected photographs that utilised a range of measuring techniques (eg rulers, paper tags) to convey scientific information about their plant. One student mastered a technique of photographing parts of his plant through the binocular microscopes that were available to students. Another student utilised the macro facility of the digital camera to capture the seed head of her plant. The high standard of visual images produced by students in every project school is a characteristic of this work that needs further research to explore its potential as part of student learning.

Overall the standard of students' work surpassed the expectations of the project team. It became clear that access to the human and electronic resources of the project was a major factor in providing students with tools they required to achieve and surpass their learning goals in the time available.

CONCLUSION

Clearly 'rich' learning situations that place students in some control of their own learning, that locate learning in environments beyond the classroom and that incorporate technologies, are emerging with the increasing availability of portable computers. This project demonstrates that, as mobile learners, students are more than capable of incorporating the use of powerful computing capabilities into their own investigations of their local environment. The results of this project contribute to a collective of high quality educational experiences incorporating emerging technologies that support mobile learning. This project has contributed to the following areas.

1. The contextualisation of mobile learning developed 'from the ground up' rather than being imposed from the designers down to the classroom teacher. This model places teachers, supported by a range of key personnel, in the position of curriculum developers and pedagogical experts, clearly able to provide high quality learning contexts for the mobile learner.
2. A theoretical framework for mobile learning which incorporates current learning theory and a theory of teaching. This emerging theory will benefit from critical feedback envisaged at this conference.
3. Exemplars of units of classwork that provide a framework for student-led inquiry incorporating mobile technology to support learning beyond the classroom.
The processes of theory building from a growing base of experiences with mobile learning are continuing as we attempt to make sense of our experiences, seek commonalities and make tentative explanations of our work. Alongside this theory building process, practical research of the classroom context for mobile learning needs to continue and a raft of questions including those identified in this paper await illumination.

ACKNOWLEDGMENTS

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HUNTING MOBILE LITERACIES: LISTENING TO THE EXPERIENCES OF STUDENTS.

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ABSTRACT

This paper draws on ethnographic research being undertaken to understand and explain the literacy practices that young people engage in when using mobile technologies. Our students are often acknowledged as being 'digital natives' or the 'Net Gen': it seems a logical step when thinking about and designing mLearning, that we develop understandings of what young people are already doing and capable of with regard to mobile technologies. The aim of this research is to examine and explain the experiences of young people using mobile technologies in terms of the literacy practices involved. The New Literacy Studies perspective is used to reinterpret student social practice in terms of multimodal literacy: assorted semiotic meaning-making processes, utilising a variety of modes of communication. Short Message Service (SMS), Computer games and the video recording of schoolyard bullying are used as examples to illustrate how we might think of student engagement with mobile technologies in terms of literacy. By focusing on the experiences of young people, this paper is a call to listen to and examine their experiences as part of mLearning research and development.

Author Keywords
Literacy, Mobile Technologies, SMS, Computer Games, Bullying

INTRODUCTION

My personal interest in understanding mobile literacies emerged in response to my exposure to Short Message Service (SMS) language in student essays. The use of 'c' and 'u' to represent whole words was cause for teachers around me to decry the scourge of SMS and its destructive impact on literacy standards. I did not see it this way. I'd always thought the use of 'u' to represent 'you' was rather clever. The problem as I understood it had to do with the misuse of SMS language in the context of a formal essay. As such, the issue was not declining standards of literacy, but rather, a need to develop knowledge about the purposes and structures of different forms of writing and communication, including SMS. But how are we to develop this knowledge, and how do we teach these to students? Do we need to teach these skills to students at all, or do they already know?

My research aims to address these very issues. Using an ethnographic approach, I aim to understand how young people – students – use mobile technologies as part of social practice, and how we can describe these practices in terms of literacy. The aim of this research is to give a voice to the experiences of students, so that we can construct pedagogies that make use of mobile technologies in ways that are authentic and relevant to the actual experiences of students. It is difficult to see how we can construct mLearning opportunities to engage students – learning activities that are relevant to and build on their experiences – without detailed studies into just how young people actually experience these technologies. My particular focus on literacy as a multimodal process, aims to cut across discipline-based subject areas. Knowledge of student 'mobile literacy' practices may be used to enhance the use of mobile technologies across subject areas.

This on-going research aims to draw together sociological and cultural studies of mobile technologies, with New Literacy Studies research, in order to illuminate the practices of students. I am interested in how the very mobile nature of these technologies, influence the types of meaning-making and communication processes that occur. I am interested in how this occurs amongst young people, the so-called 'digital natives' (Prensky, 2001) or 'Net Generation' (Oblinger & Oblinger, 2005). When and why do young people use SMS? When and why do they take digital pictures? When, why and how do they use iPods? What types of critical literacy – critical discrimination – strategies do they use? How do the situations in which they're used influence what people actually do with mobile technologies? How do students use 'pranking' or *squillo* (single ring-calls not meant to be answered, but more to say: I'm thinking of you) to create meaning (Thompson, 2005)? Understanding what is going on, leads us towards answering wider questions. Why is SMS so popular among young people in particular? What is it about their social practices in particular that has resulted in their use of SMS? What is it about SMS or mobile technologies specifically, that encourages their use by young people? What role does marketing and the commodification of 'cool' have in this process?

There is emerging policy discourse in Australia that we need to more productively use mobile technologies for learning (Watson & White, 2006). Knowledge about the current social and literacy practices of students with regard to these technologies can contribute to and enhance our knowledge of *how* to best use these technologies in educational contexts.

MOBILE TECHNOLOGIES & MULTIMODAL SOCIAL PRACTICES

As mobile technologies are tools of everyday life for many people in post-industrial societies, any literacy practices that concern them will likewise be intimately linked with social practice. The New Literacy Studies tradition, as represented by the work of the New London Group (1996) and Gunther Kress (2003), is an approach that emphasises the social nature of literacy. No longer is literacy linked merely to the ability to code and decode text, but is multimodal and intimately tied to the way people go about their everyday lives. The New Literacy Studies tradition emerges from the realisation that "…there was no singular, canonical English that could or should be taught anymore." (New London Group, 1996, 63). This is a profound shift: an acknowledgement that electronic technologies, combined with increasing local diversity and global connectedness, has resulted in language being reshaped and renegotiated.

As mobile phones are used in everyday life, any understanding of the literacy practices involved needs to account for more than language alone. This concept of 'multimodality' is a key component of the multiliteracies approach: "A pedagogy of multiliteracies…focuses on modes of representation much broader than language alone. These differ according to culture and context, and have specific cognitive, cultural and social effects." (New London Group, 1996, 64). Design becomes the central pedagogic principle in curriculum development and learning around multiliteracies:

"We have identified six major areas in which fundamental grammars – the metalanguages that describe and explain patterns of meaning – are required: Linguistic Design, Visual Design, Audio Design, Gestural Design, Spatial Design, and Multimodal Design. Multimodal Design is of a different order to the other five modes of meaning; it represents the patterns of interconnection among the other modes." (New London Group: 1996, 78).

One of the key moments in the New Literacy Studies approach is the move from the page to the screen (Snyder, 1997). The move away from books to screens for information and the increasing use of image has resulted in a decline in the predominance and primacy of the written word (Jewitt, 2006). Written information, when it does appear onscreen, is organised in terms of visual logic, resulting in situations where information on web pages is organised in frames and boxes, instead of continuous text (Kress, 2003). This is not a new piece of knowledge though: printed texts have always been organised in accordance with a visual logic; from the justification of margins in typed essays (which *looks* neater), to textbooks, newspapers and catalogues, where writing and image are organised visually. I will explain below how SMS language has evolved to make clever use of the visual nature of written language to convey information :) The use of mobile technologies is not limited to what appears and happens on their tiny screens though, but also has to do with the ways in which, and the reasons for their use in people's everyday lives: the contexts and situations of their use have an equally important impact on the practices that occur. Social practices around mobile technologies are complex and multimodal, drawing on a range of different semiotic modes, including speech, text and image. We therefore need to consider everything from emails sent via mobile devices, to the sharing of music on portable mp3 players, to taking photos or videos with smart-phones, in relation to literacy. However, where does the descriptive capability of literacy – even multiliteracy – run out: what sort of meaning-making processes can it not account for?

In all contexts, writing is 'framed' in particular ways: "Frames can be concrete, material, such as a full stop or a semicolon, the space around a paragraph, or the space that frames a finished text. Frames can also be intangible; many or most social and cultural frames are of this kind – they hold us invisibly and inescapably in place." (Kress, 2003, 122) These frames can be used to understand the visual logic in the design of texts, but can also be used to elaborate on how different forms of communication are contextually situated and constructed. Whilst the limited screen size of the majority of mobile devices has resulted in a economy of design – a process that is still in development and growing – there are wider and more variable frames around mobile technologies and their use, dependent upon context and 'intangible' aspects. So the physical size of the phone forms one frame: it has an impact on the type of information that it is communicated via these devices. Mobiles are framed by social factors also, and these factors have far more impact on the meaning-making (literacy) practices that take place. *When*

and *why* a mobile technology is used influences *how* it is used. This can be based on cultural factors – some cultures are more tolerant of mobile phone use in public than others – or on clearer regulations or rules, such as laws in Australia making it illegal to talk on a mobile phone whilst driving a car. The cultural and social framing of mobile technology use has a huge impact on the literacy practices that occur.

The multiple contexts in which mobile technologies are used – in respect to purpose and physical surroundings – gives rise for a need for the literate individual to consider more than simply the meaning of their written message, images, gestures or sounds. An understanding of the cultural context of communication is necessary. Here I use the concept of 'cultural literacy' as developed by Shirato and Yell: "The ability to negotiate between the rules of a culture and what happens in practice is what we have called cultural literacy." (2000, 3) This is based on the concept of different, specific contexts influencing the types of literacy activities that can occur. We need to look not just at the modes students use to create meaning around mobile technologies – written, image, gestures, etc. – but we also need to consider the impact of contextual factors on meaning as it is either expressed (*articulated*) or understood (*interpretation*) (Kress, 2003).   Examples where students have not made a successful connection between the context of communication and its content are easy to think of: SMS in formal essays, photos of illegal activities published on the web, the forwarding of illegal SMS or Multimedia Messaging Service (MMS) content are examples. Therefore, the concept of literacy extends at a meta-level beyond the content of a message, to in a very real way, and in line with New Literacy Studies approaches, include understandings of the wider context of meaning-making as important.

The very mobility of these devices, combined with their use as a part of social practice, results in a serious question for literacy researchers: just what sort of social practice, are theories of literacy able to account for? In essence: what are the epistemological limits of a concept of literacy? Katz for example, outlines a consistent set of postures people engage in when using mobile phones: these include the 'bent over' posture, the 'cricked neck', 'public pacing' and 'draping the body over environmental objects' among others (Katz, 2005, 177). Whilst 'gestural design' is highlighted as one of the fundamental grammars of the New Literacy Studies tradition (New London Group, 1996, 78), how are we to go about explaining what might be unconscious body positioning in terms of literacy, in terms of meaning-making using semiotic resources?   When someone talking on the phone unconsciously covers their face in worry, or yawns in boredom, can we account for this in terms of literacy? To what extent are gestures or spatial orientation important modes for interpreting the literacy event of someone listening to an iPod on a train: are they happy, sad, mad, going to work, wasting time? In order to understand the literacy practices of young people when they engage with mobile technologies, we need to extend concepts of multiliteracies into our everyday social practice. When you can communicate anywhere, anytime (ideally), that very freedom from singular places, has an impact on how we communicate.
I would now like to examine a number of examples of student's social practice around mobile technologies, and consider how we might understand them in terms of the multimodal literacy practices at play.

SMS
SMS was an unexpected development from the launch of digital networks (Levinson, 2004). Originally intended for sending technical information, it was quickly co-opted by phone users as a short, cheap method of communication.   It has evolved in its own unique, organic way, with both local and global manifestations. Hans Geser refers to this process as the 'Balkanization of language' (2005, 27). Indeed, SMS language, whilst maintaining some similarities globally, in different forms of 'technobabble' (Bodomo & Lee, 2002), varies enormously across cultures. For example, whilst 'u' and 'c' have similar meanings and uses between some English-speaking societies and Hong Kong, the use of the figure 8 varies between the two, as a result of the number's pronunciation. Whilst '8' can represent 'eight' or '-ate' for example in English-speaking countries, in Hong Kong, it's use draws on the Chinese pronunciation of '8' as 'bay'. Therefore, in English we can write 'l8' for 'late' but in Hong Kong '88' is used to mean 'bay-bay', or 'bye-bye'. Having an understanding of your audience and the unwritten cultural conventions of SMS is an important part in using it effectively.
The importance of understanding the unwritten conventions of SMS language was revealed by Larissa Hjorth when examining a case study sample group of university students, administrators and staff. A female responded pointed to 'texting' as a new form of expression, which required brevity:

"Often the initial original message is quite different from the one I end up sending; for example, if I am sending a long text message that goes over into two messages I will edit into one message. This is not because of the cost but more about the flow of the message; often it gets sent as two separate messages that hinders the message and its intentions. Recently I got a message from someone who sent six messages in a row; they were obviously familiar with texting! She wasn't concise, it was literally as if she were talking!" (Hjorth, 2005, 60)

SMS is at times blamed as being a cause of poor literacy skills in adolescents. We need to shift our thinking with regard to SMS, and instead of seeing it as an attack on traditional literacy skills, see it as just another form of language for specific contexts (Carrington, 2006). Understanding the literacy practices around mobile technologies becomes then a matter of identifying and discussing the context for this form of language with students. We can discuss with students that one-sentence paragraphs are fine for tabloid newspapers, but they are unsuitable for formal essays. The same situation exists for SMS language; this is particularly revealed when we consider that this language emerged as part of the move to the screen, and as such, has a strong component of visual meaning.

Whilst there is a linguistic element to SMS language – homophones are used frequently – there are also multimodal elements. In examining the SMS 'technobabble' as language in Hong Kong, Bodomo and Lee, identify new forms of language for online (or mobile) communication: *acronymy* - abbreviations, called 'squeeze text' by Carrington (2004) – *punctuation* can be used for visual effect, *emoticonymy* (smileys) for emotional content. With reference to New Literacy Studies and the move to the screen, there is a need to acknowledge that "all written text is visually designed" (New London Group, 1996, 81). The use of smileys and visual typology effects in SMS is an explicit example of the visual nature of linguistic communication. As technological capabilities increase, an expectation may be that the visual meaning of SMS-type messages may be further augmented with other modes of meaning-making: images, sound, animation, hyperlinks, etc.

How does SMS feature amongst a multimodal understanding of literacy practices though? As a part of social practice, SMS is used in a variety of ways: for the exchange of emotions, for rescheduling, for conversations. They are used for convenience, for competitions, for games, for fun, for reminders. How do we describe the multimodal environment in which an SMS is created, but which is also integral to it's immediate meaning, either as *articulation* or *interpretation* (Kress, 2003, 38). What modes of communication constitute being 'SMS literate'? The speed of your typing? The complexity of your text language? Innovative use of alphabetic characters visually? Knowledge of negotiated and standard SMS language forms? SMS is more of a complex literacy practice than it is often given credit for.

COMPUTER GAMES

Concerning young peoples' use of computer games, there is generally a negative public discourse. There are suggestions that they contribute to rising rates of childhood obesity and social isolation, whilst glorifying sex and violence. With the move of increasingly sophisticated computer games into the sphere of mobile electronics, we are faced with exciting and strange possibilities that blur the lines between actual reality and cyber reality.

There is a growing field of research into the educational potential of computer games: Marc Prensky (2006), James Paul Gee (2003, 2006) and Catherine Beavis (2002; with Snyder, 2004) are three people researching and advocating in this field of scholarship. Some arguments in favour of the educational potential of computer games include: that they are entertaining and engage many students, they offer contextualised learning opportunities, they can develop narrative and problem solving skills and actually involve some complex decision making processes.

But what happens to the literacy practices around computer games when they can be used anywhere, anytime. We certainly won't be able to complain about the isolating nature of computer games if people are moving around whilst them; it's not like they're locked away in isolated rooms sitting in front of computer screens. It's anywhere, anytime gaming, and it's interactive with the environment. Rheingold describes the 'Botfighters of Stockholm' (2002, 18-20), who travel the streets of the city, using their mobile phones to battle with others via virtual 'bots'. The game was always in movement, and could occur at unexpected times if someone else playing the game brings their phone within range of yours. But how do we describe the literacy practices that are occurring here?

Whilst there has always been a sense of movement and mobility in computer games – players move through virtual worlds – mobile gaming exacerbates the blurring of lines between virtual and actual (real) movement through space. As such, what does a video game become when it merges with social practice? With the rise in mobile devices featuring Global Positioning technology, the possibilities for gaming that extend beyond the screen and into social practice is a still to being developed. Already in Japan the use of RFID tags on a product allow for the situation of being able to "…walk around and point your phone at something to instantly receive more information about it." (Thompson, 2006, 58) Combined with global positioning and the ever increasing popularity of Massive Online Multiplayer Games played over the internet, this opens up possibilities for virtual game worlds which connect in a very real way with the physical world. Imagine a game for instance, where your progress through a virtual world relies on you collecting certain experiences or achieving certain tasks in the real world. How do we describe the narrative of a mobile text when it might be bound up and intertwined with everyday events, contextual influences and our own dispositions? How will the narrative of our everyday lives be changed by mobile gaming? What does a theory of literacy in respect of this need to explain?

PUBLICATION OF BULLYING
When we think about what a concept of 'mLearning' means, it is not just about how to teach students using these devices as tools, but how to develop learning programs *about* mobile technologies. This involves understanding the reasons young people use mobile technologies.

A recent issue of public concern in Victoria has been instances where mobile phones have been used to record footage of instances of bullying in high schools. Such incidences have at times made front-page news on tabloids and evoke strong emotional reactions from public figures and media institutions alike. If we look past the immoral nature of these events though, what we see is a complex set of meaning-making practices. Not only are students aware of how to video record specific information that they want – visual literacy practices – but have knowledge as to how this information can be published, with some of the videos ending up on YouTube. Why do they use YouTube? What value is gained from this form of publication? How do they determine what video content is good enough for posting? Is all this a result of mobile technologies increasing capabilities? Or is it a result of increasing glorification of sex and violence in the popular media? Is it some combination or the two, or other influential factors? Then again, there is a possible misunderstanding on the behalf of the student that publishing online was acceptable or invisible. I am just speculating of course.
Bullies are playing a power game, where they seek to gain acknowledgement and power through intimidation and violence, but why the publication of self-incriminating evidence? In the situations I spoke of above, the students were disciplined, but then again, there has always been misbehaviour despite repercussions. There is of course also cyber bulling via mobile phone: does this just constitute sending SMS, or are there other modes of communication linked through social practice? Just as with all social practice, the distasteful practice of bullying using mobile technologies is expressed though many different modes of communication.

CONCLUSION
The focus of this paper has been to suggest that research into young people's use of mobile technologies can be used productively to inform mLearning design.. We increasingly acknowledge our students as having expertise, as being 'digital natives', which cause us to rethink the relationship between these students and their teachers. The social practices of students around mobile technologies have often been a topic of concern in general public discourse. What I am suggesting is that the use of mobile technologies by young people as a part of their social practice, reveals complex literacy practices. Student use of SMS, computer games and even their use of mobile phones as part of bullying, should lead us to rethink what literacy actually means in contemporary post-industrial and mobile societies. Knowledge of the 'mobile literacy' practices of young people can inform effective pedagogies for the future that make productive use of mobile technologies for learning and are relevant to students lives.

We also need to acknowledge the dual direction of 'mLearning'; we are learners about mobile technology too: how to use them, how to design them, how they are already used, what their social roles are. With our students we share the experience of continually adapting to and understanding technological change, continually redefining literacy in our own lives.

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THE MOBILE JIGSAW – A COLLABORATIVE LEARNING STRATEGY FOR MLEARNING ABOUT THE ENVIRONMENT

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ABSTRACT

This paper outlines the application of a collaborative learning framework to a mobile learning environment in the field of science education at both the primary and secondary levels of school in New South Wales. *Jigsaw* is a strategy for collaborative learning whereby students become experts in an area, and in turn teach other students what they have learnt. We applied this to mobile learning where students became experts in the use of different mobile technologies in order to accomplish a shared task. The mobile technologies included Tablet PCs, digital cameras, USB flash-drives, and a wireless internet connection. Students were able to use these technologies while collecting information about their local environment in order to create products such as a database of plant species for the area. The successful application of this strategy enabled teachers to incorporate mobile learning into their classrooms.

INTRODUCTION

Mobile learning is becoming popular as a method that serves the dual purpose of increasing students' motivation in a particular subject area, and allowing the educational objectives of content understanding and experience with different types of technology to be met. The Federal Government's ASISTM (Australian Schools Innovation in Science Technology and Mathematics) funded a number of schools, both primary and secondary, to have access to mobile technology that they incorporated into their curriculum in the field of science. While this project involved a number of schools, only two will be discussed in this paper – one primary school and one high school. In particular, this paper will discuss the application of a well-established strategy of collaborative learning (*Jigsaw*) to the field of mobile learning. We will also outline other developments that have been inspired by this project, and that are 'work in progress'.

Teachers and lecturers need more than technology. They need pedagogically sound, effective methods that integrate technology in a manner adapted to the requirements of the subject matter taught, and students' needs. Collaborative learning, and in particular the *Jigsaw* strategy, is a well-researched tool for facilitating learning. The development of a strategy to support such learning, with a combination of these mobile technologies can be applied to many different subject areas, including both higher education and school-based scenarios.

LITERATURE

This project developed a pedagogical method, grounded in research, for using mobile technology to enhance collaborative learning. We built on the *Jigsaw* method of collaborative learning, designed for heterogeneous groups using paper-based materials. Students become experts in their area, meet with students from other groups with the same role to develop their expertise, and in turn this understanding is taught to their heterogeneous group (Slavin & Cooper, 1999). Our project is an innovative adaptation of the model using a combination of technology and paper based materials, with an emphasis on mobile technology.

There are two versions of the Jigsaw strategy; the main difference is the way that students are assessed. Students are assessed as individuals in the original *Jigsaw*, and as a group in *Jigsaw II* (Slavin, 1980). The other difference between the original and *Jigsaw II* is that in *Jigsaw II* students all read the same material, but focus on different topics, whereas in the original, students within the group are given different pieces of material (Slavin, 1980). The *Jigsaw* method has also been used for learning language (Ghaith & Abd El-Malak, 2004; Ghaith & Bouzeineddine, 2003).

Learner perceptions play an important role in successful collaborative learning situations (Beatty & Nunan, 2004). Learners with awareness of their own ability to actively participate in a task are better able to engage in collaborative tasks (Beatty & Nunan, 2004). Collaborative learning requires a plan for the work process, critical thinking, and scaffolded learning. Learners need to engage in these steps to effectively use the collaborative learning environment. Determining priorities, therefore, is also an important part of the collaborative learning process. The learner's perception of the technology is also an important component of the collaborative learning process, as learners must be scaffolded within their learning environments.

Baker et al. (2001) found that, in general, students are reluctant to express disagreement when they are in groups. They suggest that when designing computer supported collaborative learning (CSCL) environments to support interaction about science, the structure should include a debatable task; cognitive preparation for debate; multiple representations of solutions; compatible partners; and a strong understanding of the topic (Baker *et al.*, 2001). The role of the teacher is also important. Teachers should combine the role of information giver with debate moderator for the most effective role in terms of their own development and learning outcomes of the students.

A mobile learning environment encourages collaborative learning. The 'just-in-time' nature of mlearning means that collaboration can occur around the technology at any point in the process. Rieger & Gay (1997) describe the transfer of this term to education as enabling students to "receive context-appropriate information or complete a skill-building task, at the most appropriate teachable moment' (p. 216). In our project, it was not just the use of the usual mobile technology (Tablet PC) but its integration with the other technology (digital cameras, USB flash drive, etc) that provided the rich learning environment for students. Roschelle & Pea (2002) describe these types of technology as WILD (Wireless Internet Learning Devices). The authors discuss the way that WILD applications "augment or amplify an existing physical space with information exchanges" (p. 151). They also refer to the role of the teacher as a 'conductor-of-performances' rather than an instructor or co-learner.

Particularly within science, collaboration is seen as important because the task itself, as well as the method of working and the tools with which students were working, were authentic. Students were engaged in an extended open-ended investigating task where there was no 'correct' answer. Furthermore, scientists will often collaborate. To be able to manage this process, in terms of their skills with the technology, brought much more to the learning outcomes than simply the subject matter.

OUR EXPERIENCES
Our study provided an opportunity for students to conduct 'outdoor' research in a science education context. Initially, students incorporated the use of materials to conduct an investigation of an issue in their local area. All groups had access to Tablet PCs (HP Compaq Tablet PC tc1100), digital cameras, USB flash-drives. This technology could be taken and used to support data collection in the field. When students returned to the classroom, the different types of information could be incorporated into a group database, accessible to other students in the school and able to be added to by classes in the future.
We applied the *Jigsaw* strategy of collaborative learning in both high school and primary school settings. The classroom teacher in both the primary and junior secondary project schools placed students in groups of four, each student with a specific role within this home group. The rationale for allocation of students to a particular home group was left to the discretion of the classroom teacher. In one situation students were allocated to 'buddy' groups where members of the group were friends; another teacher designed groups and allocated roles according the talents and skills of the students in the class. This latter situation was evident where students with particular computer skills were allocated to the role of ICT manager.

In the primary school setting, four roles were designed for each group. One student adopted the role of group manager with the responsibility of organising the work of the group, identifying tasks, ascertaining the equipment needs for the group and representing the group in approaches to the classroom teacher. The ICT manager was responsible for the use of the Tablet PC; this person was trained in its use and could train other members of the group. The visual design manager was responsible for taking, recording and preparing the visual records for the group; this person was initially shown how to use the digital camera and could then opt to train other members of their group. The science communicator of the group was responsible for framing questions for the science experts and other experienced adults who worked with the class and then interpreting responses for the group. The science communicator also edited written information prepared by the group.

The *Jigsaw* aspect of group work was most evident when expert groups were formed around each role. Group managers met with project staff for a briefing about various aspects of the project including managing their members, the technology available to the group as well as dates and times of events for which they and their group were to be prepared. Group ICT managers worked with project staff to familiarise themselves with the Tablet PC before its use was required for class work. A similar training session was conducted for the visual design managers. This arrangement required the use of seven

Tablet PCs and seven digital cameras per class of 28-30 students, reducing the need for large amounts of expensive equipment. Students of all ages quickly mastered basic functions of the technology and willingly shared interesting features with their colleagues. ICT managers were required to be able to create and file appropriate documents ready for use by their group. ICT and visual design managers combined for training in the process of downloading pictures from the camera onto the Tablet PC, then on to the group's USB flash-drive. The availability of generic software familiar to the students facilitated their mastery of the technology. USB flash-drives enabled the transfer of documents between the Tablet PC to the school computer system. Group managers were responsible for overseeing the content of the group's USB drive as well as its safekeeping. The science communicators met with project staff who briefed them about the scientists and other professional adults that were going to work with their groups. Questions were designed and trialed, ready for the interaction with the expert.

Interestingly, during group work, a natural pairing was observed around both pieces of major equipment so that two students shared a novel piece of technology. There appeared to be easy sharing of expertise with the various managers accepting the ultimate responsibility for their role. There was little evidence of students being excluded from accessing the technology available to their group, indeed the quantity of resources seemed quite adequate for the tasks set for project. To see samples of the student work, please visit the project website:
(http://coco.edfac.usyd.edu.au/mobilelearning/peakhurstPS.php).
At the senior high school level, students worked in pairs. One student was the expert with the Tablet PC, the other with the digital camera, and both students contributed to the content required for a biology assessment task. This project also incorporated year 7 students as part of the school-mentoring scheme. Up to six year 7 students joined each senior group as a pool of research assistants with the senior students adopting the role of managing the research team. This organisation can be seen as a *Jigsaw* on two levels. The first level was that each group contributed information about different areas of the school to be displayed in a whole of school database. Then within these individual groups, students were further split into areas of speciality. At the high school, the learning potential of mobile technology was enhanced by the existence of the school's wireless network. This allowed students to transfer their work from the Tablet PCs to the school's system. It also allowed them to research the plants online as they were in the field, and to contact experts via email to ask questions. In this respect, they could email a question with a photo attached to an expert at a remote location. In preference to jotting information such as plant lists and maps of their area on paper, groups were able to create lists and area maps on the tablet that could then be saved and incorporated directly into a final report. For more information about this project, and to see samples of this student work, these are available on the project website (http://coco.edfac.usyd.edu.au/mobilelearning/caringbahHS.php).

CONCLUSIONS
The use of *Jigsaw* groups where each member focuses on development of an area of expertise critical to the work of the group can result in the immensely satisfying situation where the quality of the product is greater than the sum total of individual parts. The contribution of each member is essential to the success of the project and no, one person could have achieved the final outcome by working on their own.

One application that has come out of the work with the high school is the development of a wiki (an interactive web site). This will allow students, in combination with the laptops and digital cameras that the school has subsequently purchased, to add their information to the wiki as they are in the field. At the primary school an online database has been developed and trialed, which will allow students to upload their observations and images into an online database.

This is a unique application of this collaborative learning theory in the field of mobile learning. Incorporating mobile learning into class work can easily be an overwhelming experience for teachers. The successful application of a well-used method of structuring a collaborative learning task takes some of the risk out of using these technologies. Students become the experts in the use of the technologies, not the teachers. In our experience, students naturally wanted to explain how to use the technology to other students, and learnt to use it almost without trying. The main finding described in this paper is that the application of the *Jigsaw* method to collaborative mlearning about the environment was successful both in terms of student participation and teachers' ability to incorporate the technology into their class' activities. What needed to be prepared for the students was not instructions but a structure within which they could conduct their own inquiries. Students needed a purpose for using this technology that was

provided in terms of studying the local environment, they produced an authentic product in the databases of information accessible to both the school and to the local community.

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ABSTRACT
Over the last five years there have been a variety of mobile learning pilots and projects exploring the possibilities of using handheld computers, mobile phones, personal media players and games consoles to deliver, support and enhance learning, assessment, guidance and administration. These developments have worked within relatively narrow educational discourses. This is problematic since it potentially ignores the ways in which mobile devices and technologies are transforming society quite profoundly, creating new forms of art, business, crime and artefact and challenging existing ideas of identity, community and discourse, and consequently challenges accepted notions of education, learning and knowledge. These changes are the wider environment of the technological and pedagogical components of mobile learning.

Author Keywords
Mobile society, identity, spaces, community, postmodernism

MOBILE LEARNING IN CHANGE
Academics probably understand intuitively that technology and society are intimately and dynamically connected, each shaping the other. Education and society are also intimately and dynamically connected, each leading the other. Technology shapes much education but education has little control over technology. The dynamic between technology and society has been conceptualised in a variety of ways: the technical deterministic view, that technologies shape and mould societies; the opposing social deterministic view that technologies are continually reinterpreted by users and given new, perhaps unexpected directions and the arguably more balanced view of 'affordances', the view describing how the physical characteristics of an object interplay with the way in which we perceive and interpret the use of the object. Whilst the latter is the most balanced of the three, it is not without its shortcoming; it ignores the wider context of the objects and the culture of the user. Ling (2004) summarises these views and their difficulties and suggests a position that affordances are perhaps best in describing design issues – the concrete specifics of devices and technologies - and weaker at considering the broader social context. He argues however that a more serious criticism of affordances, in common with the other two views, is that they are essentially circular and tautological, in as much as if an object is used in a certain way, it must have the affordances to be used in that way. Hence we learn nothing.

In spite of the apparent analytic weakness of these various views, there is no denying the dynamic between society (and education) and technology and hence the importance of these issues for mobile learning. Ling offers a more useful, specific and robust framework for this dynamic by looking at a fourth view, that of the 'domestication' (perhaps socialisation would be a better word since it goes onto look at mobile technologies) of ICT, a viewpoint associated with Roger Silverstone amongst others in the UK (Silverstone & Haddon, 1996; Silverstone 1994; Silverstone et al, 1992; Haddon, 2001) and summarised as emphasising firstly consumption, not simply purchase, of an object; secondly, the view that adoption should be viewed as a process, a whole series of negotiations, as individuals, as individuals within groups and perhaps individuals against other groups, involving perceptions of need, cost, placement etc; thirdly, the view that adoption is not characterised by a binary transition, a 'flip-flop', but by phases, ambivalence and perhaps vagueness; and lastly the view that adoption, 'domestication', is both a social and a mental process. Haddon (2001) says "the role that ICTs come to play and their meaning for us both is shaped by the rest of our lives and can be shaping in their consequences. In other words, how we experience them is not totally predetermined by technological functionality or public representations but is also structured by social life". This latter point most clearly differentiates domestication from affordances as an account of the dynamic between technology and society.

In the case of mobile and wireless technologies 'domestication' is possibly a misnomer, although to be fair, Silverstone (1993) does say, "The shape of (our) domesticity has been formed as a result of the combined consequences of the social and technological changes associated with industrialisation". So there are two views suggested: that ICTs fundamentally affect what we mean by home and that ICTs have liberated our domesticity from its dependence on physical location, a recurrent issue as we shall see later. It is worth noting, especially as some of the adoption and 'domestication' takes places in organisations and society at large, that these ideas take this particular account of the dynamic between

technology and society near to Rogers' ideas about the 'diffusion of innovations' (1962), recast as the adoption of technologies by individuals and groups in society.

Having introduced ideas about the relationships between technology and society, we propose to explore how the habitual and local discourses of mobile learning take place in a wider context characterised specifically by the dynamic between mobile technologies and social change. There are multiple resonances; for example, between 'adoption' in the sense described above and 'learning' in its broadest sense (insofar as, the 'adoption' of ideas is the 'learning' of ideas), between social groups and organisations in general and educational institutions in particular, and between learners in these educational institutions and these learners situated in society. We are however specifically interested in mobile technologies and mobile learning.

Mobile and wireless technologies are becoming ubiquitous and have led to the development of 'mobile learning' (see for example the reviews by Cobcroft, 2006, and Naismith et al, 2004). This is now sufficiently mature and varied to have a major textbook (Kukulska-Hulme & Traxler 2005), a number of prestigious international conferences (most obviously, IADIS Mobile Learning in Europe, mLearn globally and Handheld Learning in Great Britain) - but no dedicated journal - and greater clarity about the significant issues (see Sharples, 2006, defining the 'big issues') and a more sharply defined research agenda (see for example, Arnedillo-Sánchez et al, 2007). There are still the significant challenges of scale, sustainability, inclusion and equity in all their different forms and also the challenge of 'blending', due to an inadequate understanding of the (rapidly changing) affordances of mobile learning vis-à-vis other forms of learning.

These developments have often been driven by pedagogic necessity, technological innovation, funding opportunity or the perceived inadequacies of conventional e-learning and have perhaps worked within relatively narrow educational discourses (see Traxler & Kukulska-Hulme, 2005 and Kukulska-Hulme & Traxler, 2007, for analyses of the aims and motivations of a sample of these developments). There are however wider challenges, those of recognising the profound societal changes catalysed by these technologies (and the dynamic between society and technology described earlier), and of recognising their local echoes and implications within mobile learning. It is difficult to document and analyse these changes partly because of their rapidity and partly because the diversity of their various manifestations so we shall start by looking at the more obvious ones.

MOBILE SOCIETY IN FLUX
The changes and increases in the personal, domestic and social use of wireless & mobile devices and technologies are easy to see; the relentless marketing and take-up of each new gadget, network, system and connectivity are also easy to see, as are the transience, diversity and volatility not only of the hardware devices themselves but also functionality, services, connectivity, protocols, operating systems, applications, peripherals, manufacturers, networks and tariffs. The effects of these phenomena are no longer merely quantitative, in the sense of allowing people, organisations and societies to do all the things they did previously but faster, better and greater, but are now 'qualitative', producing profound and fundamental changes in many, if not most, aspects of the activities of people, organisations and societies of the metropolitan and developed worlds; these technologies have led to new forms of commerce, employment, crime, artistic expression, political organisation and to new artefacts, commodities and economic assets.

Business
In terms of business, commerce and economic activity, there are new commodities such as podcasts, ring-tones and mp3 downloads (as far as pop music is concerned, these now exceed the sales of physical disks apparently) and there are new jobs and businesses built around these commodities and corporations and individuals now compete for new assets such as bandwidth and license fees. 'm-commerce' is a term coined to denote the idea of transacting business over mobile systems and recently these have taken on a new dimension in their capacity to support banking and financial transactions. Wizzit and Globe are two examples in the developing world and currently the best documented example is from Kenya (Torma & Williams, 2007). M-Pesa was formally launched by Safaricom and more than 10,000 people have signed up, with around 8m Kenyan shillings transferred so far, mostly in tiny denominations. Safaricom is confident that growth will be strong in Kenya and later across Africa. "We are effectively giving people ATM cards without them ever having to open a real bank account," said the

chief executive of Safaricom, who called the money transfer concept the "next big thing" in mobile telephony. The service is simple and users hand over the cash to a registered agent - typically a retailer - who credits your virtual account. They can then send between 100 shillings (74p) and 35,000 shillings (£259) via text message to the desired recipient - even someone on a different mobile network - who cashes it at an agent by entering a secret code and showing ID. Companies will be able to pay salaries directly into workers' phones - something that has already attracted the interest of larger employers, such as the tea companies, whose workers often have to be paid in cash as they do not have bank accounts (Guardian, 2007). One possible consequence is to move the balance of banking power away from the banking sector and towards the telecommunications sector. In a similar sense, all the other commercial and business activities based around mobile and wireless technologies are expected to challenge or erode more established formats.

Mobile and wireless technologies are also changing the nature of work itself more pervasively, especially that of 'knowledge workers' - and this includes teachers and lecturers (and students). These technologies allow workers to work away on the move, to work away from base and to work with 'just-in-time' support improving quality, flexibility and independence. Mobile users enjoy a certain freedom from time and space (*eg* their desk). They are however also constrained in that they are never truly alone. Mobile workers relinquish control when they make themselves constantly available to others. Also, what were once private places become public territory. And what were once public places (such as airport lounges, train stations and hotel lobbies) become private (professional and personal) through email, mobile text and voice interaction – a theme we return to later. Working on the move extends far beyond the home office, or of bringing the office home. Mobile technologies are transforming the way people manage their time, offering greater accessibility and flexibility (Perry *et al*, 2001). There are of course already reservations about surveillance, supervision and loss of privacy ("You Can Run but You Can't Hide", in the words of the Carphone Warehouse commercials); about deskilling and increases to the working day; and about loss of autonomy and control (Gayeski, 2002). Devices such as PDAs, Blackberrys and mobiles have allowed people to check their e-mail and perform many of their work activities anywhere they may be, known in some circles as the "day extender" syndrome (Sullivan, 2003). So we see the erosion of the boundaries between personal and time and space (and implications presumably for learning insofar as it might be seen as 'work'))

Behaviour
In the terms of crime, mobile technologies are facilitating existing types of crime such as fraud or identity theft. They are also however instrumental in wholly original types of crime, such as 'happy-slapping' and 'bluejacking'. The former may have started as a harmless prank several years ago but has escalated to bodily harm and even murder; in one case, David Morley, a 38-year-old South London barman, was beaten to death on 30 October 2006 by a gang of four young people whilst one of his killers filmed the attack on a mobile phone (BBC, 2006a). The latter uses Bluetooth technology to transmit material, sometimes intimidating or offensive text, anonymously to nearby devices prior to 'pairing'. In the words of one exponent, who set up and runs the bluejackQ (Bluejack You) website, "I came across the idea of bluejacking at an online discussion forum and it immediately struck me as a fun thing to do," She said the "priceless" expression on the face of her first victim as he tried to work out what was going on has turned her into a regular bluejacker. " This, mixed with not knowing whether the victim will react in an amused/confused or negative way gives me an adrenaline rush," she said (BBC, 2006b).

Mobile and wireless technologies offer improved surveillance; services that allow parents to locate their children are one beneficial aspect of this (one commercial product "Child Locate" at http://www.childlocate.co.uk/ "could also help you care for other vulnerable loved ones, disabled, old, diseased or on their own."). Mobile and wireless technologies are used by states and corporations, for example in the apprehension of people suspected of the London bombings of 7 July 2005 using their location within mobile phone network cells (BBC, 2006c).

The political and public life of many countries has also seen the emergence of 'citizen journalists' using camera phones to capture events, such as the London bombings of 7 July 2005, as they happen and disseminate them through conventional news outlets or through social software sites like YouTube, making news coverage more fragmented, complex and decentralised. There are clear parallels here between mobile technologies as the vehicle for decentralisation/democratisation and the perceived shift from 'web1.0', a technology for readers, to 'web2.0', a technology for writers and as Owen (2005) points

out 'the images that defined the media coverage of the July 7 London terrorist bombings […] came not from professional news crews but from everyday people'.

Alongside this has been the exploitation of mobile technologies, usually SMS, to organise impromptu, 'grass-roots' or anti-establishment political rallies, demonstrations and actions, for example the use of SMS in the anti-government protests in the Philippines that brought down President Joseph Estrada (Raphael, 2003). A more unpleasant example occurred on 11 December 2005, in Sydney's Cronulla beach in the southern suburbs, where there was a race riot. "At the very heart of this state of siege and the fear, outrage, and sadness that gripped those living in Sydney were the politics of transmission. The spark that set off this conflagration was widely believed to have been caused by the transmission of racist and violent "calls to arms" via mobile text messages" (Journal of Media & Culture 2005). Another emergent activity is 'flash-mobbing'. This account of the first outbreak in August 21st 2003 in Melbourne (*sic*), gives a sense of it,

> "They swarmed the steps of Flinders Street Station at 5.24pm ten days ago, slipped on yellow, dishwashing gloves and pointed their fingers toward the sky, before vanishing into the peak-hour crowd. It was all over in precisely one minute — 70 Melbournians amassing for an instant of fun. They call it flash mobbing and you can expect to see plenty more of it on our streets. This newest theatre-sport appeared in June when the world's first flash mob descended upon the carpet section of Macy's department store in Manhattan. About 200 mobbers surrounded a large oriental rug saying they wanted the $A15, 000 "love rug" for their pad.
>
> Since then, with the help of the internet's free discussion groups and mobile phone SMS technology, the flash mob phenomenon has spread across Europe, the Americas, and Asia, with 200 potential mobs registered on websites like www.yahoo.com.
>
> According to the unofficial website, www.flashmob.com, the amorphous movement's credo is: "Breathing fair and balanced life and vibrance into the dull corners of modern life." If emitting a spark of hilarity in our streets is the sole aim, these events are a resounding success." (see www.flashmob.com for further accounts)

Rheingold (2002) and others describe the more general version of these various group phenomena as 'swarming'. In his book Smart Mobs, he describes "thumb tribes" and "the power of the mobile many". In this context, he explores the power of masses engaged in the furtive exchange of SMS messages. He cites a group of mobile phone users in Stockholm, for instance, who exchange SMS messages while on the public transport system in order to avoid fines for ticket-less riding. These mobile fare jumpers alert each other to spot checks by transport officials by sending out short messages to a distribution list.

Mobile technologies have also found religious or spiritual applications; Reuters (2003) reported that,

> "Connecting on a spiritual level with one's deity or deities of choice can be a very difficult, time-consuming and testing process. That is unless you're a BPL Mobile subscriber. Indians can send an SMS PUJA (prayer) to BPL and have the prayers recited for them at a popular Bombay temple, during the annual Ganesh Chaturthi festival. For just 51 rupees or $1.10, subscribers can avoid the hassle and aggravation of temple queues and text Ganesh instead. More than 5,000 devotees of Ganesh have tapped into the service. "It helps our subscribers get some sort of a pious feeling," said Krishna Angara, chief operating officer of BPL Mobile. To assuage any fears that a prayer did not go through, BPL sends customers a receipt with some special deals and a portrait of the Elephant-headed Ganesh."

The Pope has now also turned to texting (Scotsman, 2003). Messages are sent from the press office of the Holy See. Signed-up users receive SMS "thoughts for the day" derived from the Pope's speeches and homilies. Services are available in Italy, Ireland and the United Kingdom. In the UK, each message costs the user 25p, and this is shared between the network operator, the Vatican and Italian technology provider Acotel. These technologies have been used in the service of all major religions and there are, of course, serious studies of such phenomena, for example those with Catholicism in the Philippines (Ellwood-Clayton, 2005). The International Telecommunications Union (ITU) continues to document all sorts of news about messaging (see http://www.itu.int/osg/spu/ni/futuremobile/content/messaging.html)

We will see later see the emergence of new or changed expectations about acceptable behaviour; new etiquettes and ethics, mixed in amongst emerging communities; new forms of language and crucially, new forms of communications but at the very least, this informal account of social and cultural change ought to provoke questions about the role and nature of education and learning and how they can be delivered and supported most effectively and appropriately.

SELF,COMMUNITY, DISCOURSE IN FLUX

More profoundly, social observers (see for example, Katz & Aakhus, 2002; Plant, 2001) describe aspects of the ways in which personal wireless and mobile technologies redefine how we think about discourse, identity and community – who we are, how we communicate, what we belong to. In general, the relations between mobility (and personal mobile technologies) and culture (and hence discourse, community and identity) are now a growing research area (see for example Urry, 2000; Sheller, 2004; Sheller & Urry, 2003; Sheller & Urry, 2006; Souza e Silva, 2006; Tamminien et al, 2003). Most of the literature currently concentrates on mobile phones rather than other specific technologies or mobile and wireless technologies more generally, and focuses primarily on social use and professional use and on teenage use. It often concentrates on gathering data about the minutiae of specific social interactions and as yet no very clear generalisations emerge. It would however be reasonable to assume that it is indicative of similar albeit smaller effects in other activities, with other users and with other mobile and wireless technologies.

One can, for example, see a room of people, physically present but each remote from the others and engaged via mobile and wireless devices with other people physically elsewhere ('absent presence', in the words of Gergen, 1996, who talks about the family living room but might be describing the modern university lecture theatre). There are countless other common-place examples such as being in a public space listening to people having the most intimate conversations on their mobile phones, hearing people using their mobile phones, ostensibly the tools to demolish location, opening the conversation by saying exactly where they are; seeing people gesticulate on the mobile – frantically (Ling, 1997). Cooper (2002) too looks at the way in which mobile technologies exist at the intersection of physical and virtual space, similar to Gergen's 'absent presence'. Virilio (2000) looks at Gergen's 'absent presence' in a different way saying "everything arrives without any need to depart" and also talks about the instant availability of information leading to a disconnection from the environment, "closer to what is far away than what is beside us, we are becoming progressively detached from ourselves". Another view is that mobile phones tend to weaken communities (e.g. families or pre-determined static groups) while at the same time strengthening networks (i.e. decentralized and constantly evolving social groupings constructed by each individual). (Geser, 2001).

In general, the tension between remote and co-present social interaction has not yet led to the establishment of any social norms. For this reason, there is general concern that the use of the mobile phone may be affecting social behaviour. Two areas of complaint stand out, firstly, the mobile voice: many mobile users tend to speak on their mobiles about very private issues, and more loudly at that, resulting in forced eavesdropping; secondly, two places at once: the complexity of managing two sets of social contexts at the same time (Ling, 2002).

In a similar remark about time and space Ling (2004) talks of the 'microcordination of everyday life' alongside the 'softening of schedules' afforded by mobile devices whilst Harvey (1990) makes a direct link between mobile technology and the condition of postmodernity explicit when he proposes the conquest of space through time (specifically faster travel, cheaper telecommunications) by these technologies. Kopomaa (1999) argues that the mobile phone is so well designed to facilitate dramatic decentralization of communications channels that he calls it "the postmodern form of communication". These remarks about space, place and mobile technologies predate the increase in context-aware technologies and location-specific services, which could be said to re-unite (or perhaps enhance and augment) the virtual with the physical.

As Plant (2002) has noted, mobiles have created "simultaneity of place": a physical space and a virtual space of conversational interaction. It can also be said that there has been an extension of physical space, through the creation and juxtaposition of a mobile "social space". This has led to a constant "permeability" (Geser, 2002) between the separate contexts of social life. For instance, individuals have often been observed talking on the phone at a restaurant table, while their dining partner either looks elsewhere or is similarly engaged talking or texting on their own mobile device. The intrusion (or potential intrusion) of remote others, in any given social context, has become commonplace, and even anticipated.

Similar observations are made about media players such as Apple iPods (Bull, 2004), "The use of these mobile sound technologies informs us about how users attempt to 'inhabit' the spaces within which they move. The use of these technologies appears to bind the disparate threads of much urban movement together, both 'filling' the spaces 'in-between' communication or meetings and structuring the spaces thus occupied."

Several observers point to the ways that mobile technologies are catalysing the definition, often on-the-fly, of the boundaries between public and private spaces and between public and private discourses and leading to the creation, evolution or fragmentation of the protocols and ethics that local to different devices and different sub-cultures. Cooper (2002) makes the point that thanks to the mobile phone, the private "is no longer conceivable as what goes on, discreetly, in the life of the individual away from the public domain, or as subsequently represented in individual consciousness" since private conversations now take place spontaneously in previously public spaces. This leads to new social forms. Goffman (1971), for example, noted the phenomenon of 'civil inattention', where in certain situations it is customary not only to not speak to others but to avoid looking directly at others. This management of gaze is one way in which the boundary between public and private is negotiated and is now often a characteristic of creating a private space for mobile phone conversations in a public setting; a similar concept is the 'tie-sign', those signs that keep a face-to-face encounter live and 'in play' whilst servicing an interruption caused by a mobile phone call. The recipient of the call is obliged to "play out collusive gestures of impatience, derogation, and exasperation" according to Goffman. These two small and specific examples are just two instances of the wider transformation of discourse and social interaction as society engages with mobile and wireless technologies. These examples looking particularly at the fluid boundary between public and private are especially important because of the relationship of privacy to identity.

Much of the use made of the mobile phone in public is coupled with a wide set of non-verbal action and interaction. (Murtagh, 2002) If a mobile phone rings in public and is answered, a couple of responses have been observed. First, the called party typically moves their gaze away from the direction of those present, to a neutral place. In some cases, the called party moves their head downward, turns their upper body, or steps away from those that are co-present. Strangers present typically look at the mobile user briefly and then return to what they were doing. If in a social group, others present often display body language to indicate that they are not listening in on the mobile phone conversation, i.e. they would speak among themselves, turn their upper body away from mobile phone user, or simply move away.
Mobile media players such as iPods can serve a different function in defining space, they "can also be used as a form of conversational preserve, delimiting who the user wishes to converse with. On an everyday level, the use of an iPod is a method of not attending to interactional possibilities" (Bull, 2004).
It is clear that we have not had sufficient time, as a society, to adapt to this new technology, with its overwhelmingly pervasive nature. However, patterns of behaviour are already becoming evident. The initiatives mentioned above represent a means to manage the potential embarrassment surrounding the public audibility of private conversations (Murtagh, 2002), or in other words "forced eavesdropping". It is an attempt to respect privacy (of oneself and others) in a public setting, or to create a private environment within a public one. An unanswered mobile phone is frowned upon, as are long intimate mobile conversations in public settings. Many who answer phone calls in meetings or quiet areas are subject to glances of admonition by others.

Indeed, many argue that mobile phones have served to change social etiquette. For example, people seem to be less committal. The "approxi-meeting" (Plant, 2001) is now standard practice: mobile phone users rarely set an exact time and place for a meeting, the excuse being that details could always be worked out later by SMS. The habit of "keeping options open" or the "multi-meeting" has also been enhanced by the use of mobile phones, *ie* users often make several approximate and tentative appointments, deciding only at the last minute the meeting they would attend (depending on the value they ascribe to it). The fluidity of time is reinforced by the capacity of TVs and media players to 'time-shift' the consumption' of broadcasts and performances; the arrival of retail mobile digital TV will accelerate this.
With the advent of ICTs, our sense of time is no longer necessarily governed by linear clock time, but can instead be "socially negotiated" (Sørensen *et al*, 2002) whenever needed. The traditional segregation of context disappears, in that private life can interrupt professional life and vice versa. For a long time, before teleworking, the workplace was a "safe heaven" of sorts, when the door was closed

and the phone (if there was one) forwarded. But for the modern working nomad, the only place that might guarantee some disconnected time is on a train or plane as it passes out of network coverage.

All of these remarks have a significance – as yet unclear – for learning. Spaces and times used to be clearly delineated for learning and now as we have seen, mobile and wireless technologies are transforming and eroding the boundaries between different types of time and different type of space. At the same mobile learning struggles between a conceptualisation that grows out of these new mobilities and a conceptualisation based around old learning made mobile.

The search for a sense of belonging has always been an important human struggle. Mobile technologies have certainly had an impact on this. With the advent of anywhere, anytime mobile technologies, the sense of belonging to place may slowly be giving way to a sense of belonging to a communications network: "those emotional elements that are lost in the relation with space are transferred to a social level, that is loyalty, the sense of identification, familiarity, stability, security, and so on".

Identity and privacy are clearly linked and this human right to privacy has two important aspects, the freedom to control personal identifying information and the freedom from interference or disruption. The mass distribution of targeted information via SMS has important implications for what might be termed "interpersonal surveillance". Although the term surveillance has typically been associated with activities of the state, it can be used to look at "mobile information gathering and communicative availability" (Brown *et al*, 2002) Social groups can track the whereabouts of particular individuals, and communicate this information instantaneously and directly to members of a large network.

Another relationship is that between identity and community and again we have seen mobile and wireless define sub-cultural communities, for example the community defined originally by its invention and adoption of 'txt-speak'; the continued existence of this in the face of predictive text is irrational and hence possibly important. Devices themselves can also define community. The Sony Walkman (du Gay, 1997) was clearly the icon of a particular youth culture (whilst also demolishing the locatedness of music) and the pager in its day did something similar for parts of business community. Katz & Aakhus (2002) describe behaviour with the mobile phone signifying power structures and social classes on construction sites. A rather different aspect of the impact of mobile and wireless technologies and identity is the number of children, according to a local web-site (www.reporter.co.za) being given names like Vodacom and Voicemail!

Language defines community and language mediates communication; and learning is a form of discourse. It is defined (or bounded) by perceptions of discourse (perhaps literally by educationalists who espouse the conversational framework, Laurillard, 2002), so education must necessarily be redefined by those technologies redefining discourse and community.

Mobile technologies and devices also redefine learning by the way they redefine the nature and significance of knowledge. Mobile and wireless devices deliver knowledge 'chunked', structured and connected in very different ways from the lecture, the web and the book. Speech is necessarily linear, finite, time-tabled and location-specific; books are substantial, linear, usually hierarchic, location-independent and referenced 'just-in-case'. We now have heuristics that allow computers and then the web to deliver knowledge quickly, effectively and on-demand but the structure, organisation and authority of knowledge is now screens of knowledge with hyperlinks. Each new technology reshapes knowledge by delivering it and mobile and wireless devices deliver knowledge in even smaller chunks, with a far greater organisational and navigational overhead; truly 'anywhere/anytime' knowledge referenced 'just-in-time'. Mobile and wireless technologies have the capacity to redefine learning in another way. Historically, education has been the reductionist process by which technologies, again the lecture, the book and the web, but also the presentation, the simulation and the role-play, have been used to bring a depictions and descriptions, basically abstractions and models, of the outside world onto the campus and into the classroom. Now mobile and wireless technologies can take education back into the outside world but in doing they challenge education as a process of 'tidiness' and abstraction and engage with the potential 'messiness' of the world outside.

Postmodernism
Many of these ideas about the impact of mobile and wireless technologies on discourse, community and identity resonate with those of postmodernism. One aspect of this resonance is postmodernism's 'incredulity at meta [grand] narratives' (Lyotard, 1999); in our case the idea that there is a widely, if not universally, accepted corpus of knowledge that education is there to deliver. Mobile and wireless technologies support purely personal and indeed individual learning, possibly fragmented and isolated learning, possibly 'user-generated', each individual devising their own private ontology. In this sense, mobile and wireless technologies erode the liberal, modernist and Enlightenment view of education. And in different sense there is a resonance with Bauman's (2001) talking of fragmented societies,

> "The overwhelming feelings of crisis (in education), of 'living at the crossroads', …have little to do with the faults, errors or negligence of the professional pedagogues or the failures of educational theory, but quite a lot to do with the de-regulation and privatization of the identity-formation processes, the dispersal of authorities, the polyphony of value messages and the ensuring fragmentation of life… Beyond all this slicing and spicing, one can sense the crumbling of time. (Crisis) plays havoc with all the rules … the fragmentary life is lived in fragmentary time."

Other observations, those about surveillance, resonate with Foucault (1979) and his attachment to Bentham's 'panopticon'. Foucault took Bentham's image of a prison equipped with pervasive and perfect surveillance as a metaphor for postmodern society, a society where such surveillance need not actually be exercised because it becomes internalised and habitualised, forever changing our relations with each other and ourselves through what he calls 'technologies of the self'. In his words, "there is no need for arms, physical violence…. Just a gaze. An inspecting gaze, a gaze which each individual under its weight will end interiorizing that he is his own overseer, each individual thus exercising this surveillance over, and against himself" (Foucault, 1977).

CONCLUSION
This informal account has not explicitly spelled out many of the implications for mobile learning, nor made the extrapolation from SMS or mobile phones to other mobile technologies, nor attempted to work from the local and specific to something more abstract and general. It can be read at several different levels. At the most superficial level, it says that mobile and wireless technologies are changing the habits, preferences and needs of people, groups and society and thus that learning and education must change too in order to remain relevant and useful (probably the technical determinist view); it says that mobile and wireless technologies are increasingly shaping the content and delivery of education and at the same time redefining knowledge, learning and education and at the most profound level, it says that the dynamic between technology and society must now be seen increasingly as the dynamic between mobile technologies and mobile societies (perhaps either the affordances or domestication of ICTs views) and that this new dynamic is just one symptom of the transition to postmodernity (and so any attempt to even talk in terms of technology and society may be merely another modernist meta-narrative).

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RESEARCH OF DEVICE ADAPTING BASED ON MAS IN FIELD OF MOBILE LEARNING

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ABSTRACT

Mobile learning means learners can access course materials at anywhere and at anytime with mobile devices; however, because of heterogeneous computing platforms, which means that different types of devices operate in different ways and have different capabilities, some course materials may not be in a unified format which can be accepted by different mobile devices. To make course materials available on these mobile devices as well as on desktop systems, this paper provides an intelligent software agent model which is capable of adapting to the heterogeneous mobile computing environment. The agent is able to recognize mobile client's capabilities and can convert the course materials into the desired format automatically.

Author Keywords
Mobile Learning; Agent; Device adaptation

INTRODUCTION
With the development of economics and mobile communication technology, various mobile devices such as mobile phones, PDAs and so on have gained rapid popularity in society and a lot of individuals and groups have realized the application prospect of mobile devices in e-learning (Cui Guangzuo, 2001). The Multimedia Research Centre of University of California at Berkeley in America built up Mobile Education Group in 2000 firstly. The Group did educational experiments focus on middle school students how to use mobile phones, discussed the application of mobile education in virtual universities, and then carried out two research projects—MOBIlearn and M-Learning supported by European Commission. In January, 2002, Mobile Education Laboratory of Peking University carried out the pilot project of The Theory and Practice of Mobile Education of Chinese Ministry of Education. That project marked that the prelude of mobile education had been started on the stage of our long-distance electrochemical education of China. Although the history of mobile learning is not so long, its development is very rapid. The scope involved in this study is very extensive and the form is also diverse (http://www.mlearn.org.za/). During the period from 2003 to 2004, device adaptation of mobile learning began to be noticed. However, now, the research of mobile learning is still at the stage of exploration and the problems of device adaptation haven't been settled, which, to some extent, restricts the developing of mobile learning. This paper provides an Agent model of device adaptation in mobile learning and discusses how to solve the problems of device adaptation by means of Agent model.

DEVICE ADAPTION
Device adaptation is also called device independence, which, in a broad sense, refers to that operation system treats all the peripheral equipments as files (http://www.w3.org/TR/2001/WD-di-princ-20010918/). Once their drivers have been installed, any user can operate and use these devices in the same way as using files, and it is unnecessary to know the concrete existing formats. From its concept, we can learn that the key of device adaptation is the adaptation capability of kernel. When we apply the concept of device independence to general network environment, it will illustrate how various terminal devices communicate with web servers through different devices.

In the field of mobile leaning, learners use different terminal devices to obtain the learning resources through network. Because of the differences among the software and hardware of devices, the learning resources will display a variety of effects, even mess , disorder, or abnormal login, which seriously influence the spread and development of mobile learning. In order to make users have friendly interfaces in the course of browsing learning resources with different devices, we can establish a device adaptation system between server and client terminals in general network environment and achieve the device adaptation in the general network environment. (Mike Sharples, 2002) .

AGENT
In recent years, agent technology has become one of hotspots of distributed artificial intelligence, and has been applied widely in many fields of computer science. When constructing mobile learning system, multiple Agent techniques can be taken in and advantages of the multiple agents can be made full use of to meet the inherent need of the system The reasons for adding multiple agents are as follows.

- The features of Multiple agents such as sociality, independence, collaboration, reaction and so on, can comply with the basic needs of mobile learning system

- The agent system is apt to be understood and accepted by software developers and designers, for multiple agents have the same mode for problem solving and computing as that in real life. Therefore, imitating the structure of human society can be used to construct the structure of multiple agent mobile education system.

- The multiple agent system provides a mechanism, which sets up an association of disperse autonomic units effectively and completes jointly complex tasks by cooperation and coordination. Multiple Agent system provides a relatively flexible and loose restrictions of individual entry and exit. Such distributed collaborative mode that collaborate according to need and couple loosely is very important to dynamic learning system and suitable for building up the model of mobile learning system.

- Task disassembling mechanism of multiple agents provides feasible basis for disassembling complex tasks in the learning system.

Based on the previous consideration, bringing multiple Agent techniques into mobile learning system can improve the intelligence, self-learning and adapting ability of the system, and thus, can create a better learning environment to attract the interests of students, undertake individualistic education and improve the educational effects. (Ye Xiaoping et al., 2006)

MODEL CONSTRUCT

Presenting Problem

To meet the need of mobile learning and exert the advantages of mobile learning adequately (http://www.mlearn.org.za/), this paper shows how to solve device adaptation problems in mobile learning to make learner acquire learning information via different devices and get continuous and harmonious e-learning environment.

- To all kinds of familiar terminal devices such as mobile phones, PDAs, PCs and so on, make use of Agent techniques to identify automatically the types of devices and get the code of the type. E-learning allows various mobile devices to obtain learning resources by wireless network and Internet. But because of the varieties of the mobile devices and the diversity of standards and protocols, we need to insert some agents possessing online competence between terminal devices and teaching platform server. Those agents can transfer metadata of software and hardware units, transform information among heterogeneous protocols and classify intelligently devices.

- Acquire Software and hardware running environment information of this type device according to codes of device type.

- Clip teaching content and transform its format according to the characteristics of the above software and hardware information and e-learning environment, that is, to transform the same information description into different information releasing forms such as HTTP, XHTTP, WML and so on. In order to realize information transforming, it is necessary to create description structure, regulation and transforming style sheets of course resources.

Model Construct

According to the above analysis, a device adaptation model based on MAS is shown in figure 1. In this model, agent role distributing is conducted. The task, characteristic and their mutual relationship of all kinds of agents showed in figure 1 are described respectively in the following.

- User Agent

The main task of user agent is to extract device information code when client sends application to server. When client sends application to server, HTTP application information is created. And the information includes a part of software and hardware information of client. The main work of user agent is to abstract the information of this part, transfer the abstracted information to device identifying agent group, identify and classify devices.

- Device Identifying Agent Group

Device identifying agent group includes device identifying agents, all kinds of device agents, matching agents and coordinating agent. The structure is shown in figure 2. Its main task is to identify different types of client terminals(different display formats, bandwidth, platform and so on) and to classify. The cooperative relationship of these agents is as follows.

According to the related information abstracted by user agent, coordinating agent sends order to the corresponding device agent. Device agent sends the concrete performance value obtained from device description information base to knowledge agent to deal with. If all of the device agents can't find the description matching with current device, it will feedback "fuzzy matching" message to coordinating agent. Then the coordinating agent sends it matching agent, whose job is to index the most similar device description information. In the above course, it is needed to research the description methods, machine learning and deducing of device information.(Yang Bei et al., 2006)
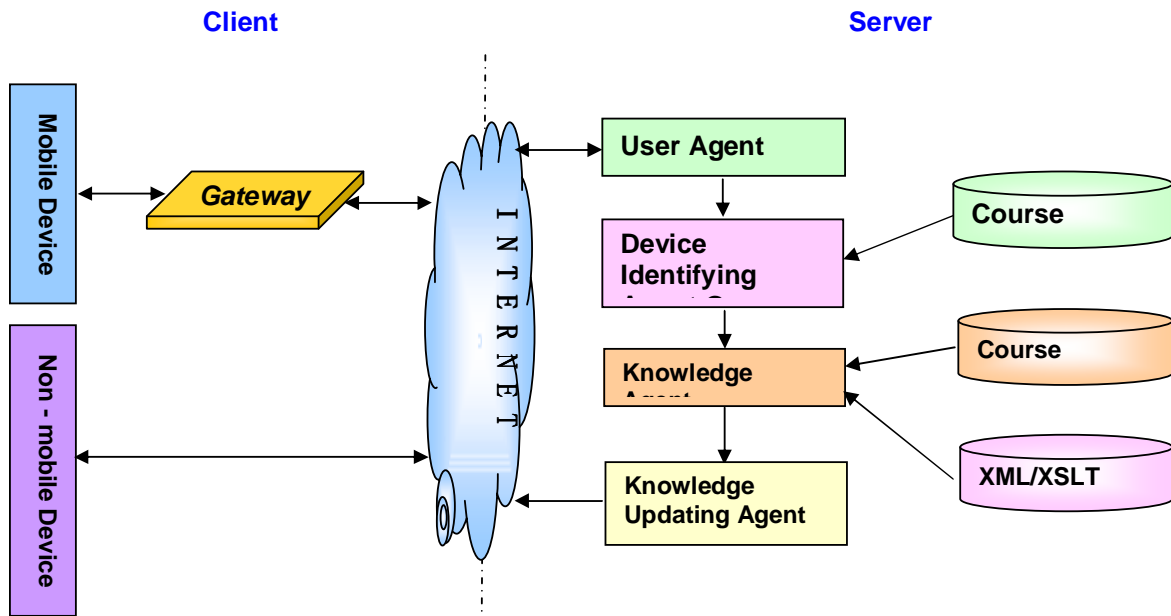
Figure 1. A device adaptation model based on MAS.
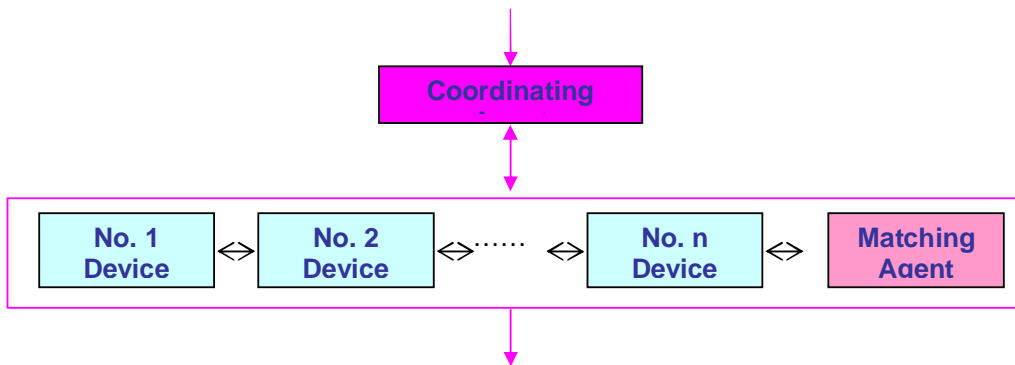
Figure 2. The structure of Device Identifying Agent Group.

- Knowledge Agent

The main task of knowledge agent is to search matching course information description and XSLT style sheet in XML /XSLT base, gain supporting information of course information transforming, and provide it to device updating agent according to the result of device identifying and classifying.

- Knowledge Updating Agent

The main task of knowledge updating agent is, according to the description information of course resource XML and XSLT transforming style sheet gained from knowledge agent, to transform XML description format of course information into releasing format supported by terminal devices, accordingly achieving device adaptation. The process is shown in figure 3.
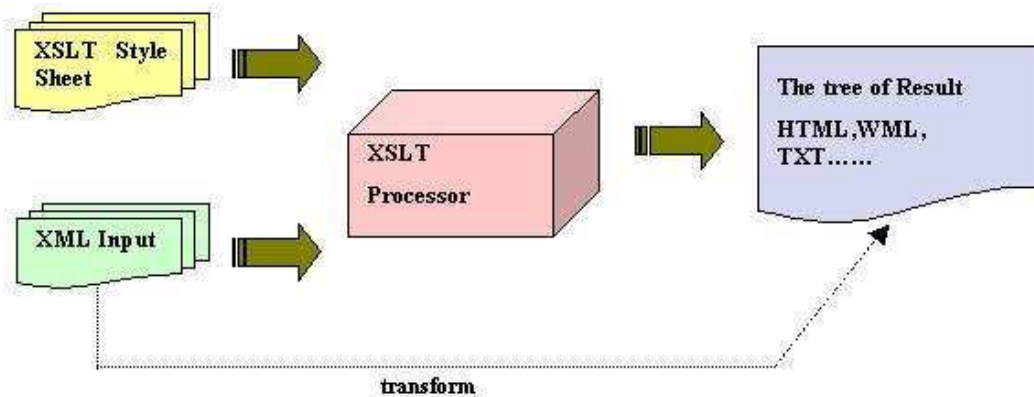
Figure 3. The process of transformation.

System Implementation
This system can adopt cross platform software framework based on J2EE, use XML to describe mobile learning resource, JADE (Java Agent Development Framework) to serve as Agent developing platform and SQL Server 2000 to serve as back-end database.

CONCLUSIONS
The rapid popularity of mobile devices in economic life of society propels the application of mobile devices in education learning. Therefore, it is necessary to transform existing or new education resources into format suitable for mobile education.

The paper provides a device adaptation system model based on Agent in mobile learning. The main function and characteristic of this model are that mobile learning system can support all kinds of devices such as all kinds of brand mobile phones, PDA, a variety of portable computers with different types, PCs and so on, according to need and can shorten the time of constructing education resource web site effectively. On one hand, it can shorten the time of developing course resources (it is not necessary to create different formats of course resource copies). On the other hand, it can shorten the time of packaging and deploying course resource. To other large institutions that need support multi-users, this model also will provide effective reference for their future development.

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SHORT PODCASTS: THE IMPACT ON LEARNING AND TEACHING

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ABSTRACT

This paper presents the findings of a podcasting trial held in the first half of 2007 within the Faculty of Economics and Business at the University of Sydney, supported by The University of Sydney Apple Australia Scholarship. This study investigates the impact of podcasting on 30 postgraduate marketing students. The majority of students are from a non-English speaking background (NESB) with over 70% international students.

Over three intensive weekends, the lecturer provided 5 audio podcast episodes of up to 15 minutes each about information on the assessment tasks. Students subscribed to the podcasts via the unit of study Blackboard site. Data was gathered using a pre-trial survey for feedback on the students' understanding and potential approaches to using the podcasts. A post-trial survey was conducted to see how students used the podcasts and if they received any learning benefits.

The results show that 96% (n=28) of students stated they had gained learning benefits from using the podcasts and liked the flexibility of the format to support their learning. What is surprising is the approach students use to listen to the episodes, which identified them not taking full advantage of the mobile learning opportunity available with podcasting. Rather students listen to podcasts at home in order to concentrate on the learning process

In conclusion, if we are going to take advantage of the opportunities afforded by podcasting to their potential in higher education, we need to investigate the appropriate types of podcasts, why they are being used, where the most appropriate location for listening is, and how they would best be used by students to improve their learning.

Author Keywords

Podcasting, eLearning, flexible learning, mobile learning

BACKGROUND

Podcasting is a popular form of mobile learning that enables lecturers and students to make connections. A portmanteau of the words iPod (Apple's mobile device) and broadcast (in this context, transferring data over a network to users) (Chan, Lee et al. 2006; Lim 2006), a podcast is a multimedia file that is delivered via the internet to a computer. A syndication feed enables new podcast episodes to be automatically *pushed* to subscribers' personal computers, freeing people from the need to check and manually download newly available content. Podcast files can then be transferred to digital audio players, enabling people to listen anywhere, anytime. From an educational point of view, podcasting has the potential to foster flexible learning that gives the learner more control over where and when he or she wishes to access learning materials.

While podcasting has been utilised in broad scale university-wide projects (e.g., Duke University and Washington University) and also adopted by many individual teachers in higher education, the current literature is limited in its assessment of the effectiveness of podcasting for student learning. There is little description of how to embed podcasting in a pedagogically sound way, beyond recording classroom lectures or tutorials. Although this situation is not surprising given the recent emergence of podcasting as a learning tool, the implication is that there is no evidence-based model to be replicated.

The research literature lists at least four ways how podcasting may be valuable for learning. The most commonly cited is supporting mobile learning. Once learners have downloaded podcasts, they can listen whenever and, if they are listening on a mobile device, wherever they wish. For example, Chan and Lee (2005) create podcasts that are short enough to fill times students are usually unproductive or idle, such as when driving or on public transport. Bull (2005) and Chan et al. (2006) refer to this as *dead time*. Other reasons to use podcasting include: younger cohorts of students regard it as a socially appealing form of mobile information and communication technology (Maag, 2006a); it can be used to encourage collaboration and engagement in learning (Warwick, 2005); it can cater to the needs of students with an auditory learning style.

There are several approaches for integrating podcasting into learning and teaching. The most common is to deliver recordings of classroom lectures (e.g., Shannon, 2006; Maag, 2006, Moss, 2002, Aldrich *et al.*, 2006, Soong, 2006). Other approaches include giving students oral feedback on group presentations

(Maag, 2006a), classroom activities such as peer reviews of student papers, audio learning objects designed as supplementary materials to fulfill certain learning objectives (e.g., Chan and Lee, 2005; Chan et al., 2006) and delivering student-created learning artifacts (Warwick, 2005).

Evidence of the pedagogical value of podcasting is limited and principally based on student evaluations of podcasted lectures. The available data suggest that, in general, most students report positive evaluations of lecture recordings. In a study by Tynan and Colbran (2006), most respondents (82.1%) say that podcasts of lectures are important or very important, and 65.3% said that podcasting assists their learning. In a study by Lane (2006), students find podcasts helpful for preparing for homework and exams, catching up on missed lectures, clarifying lectures and expanding lecture notes. The research has shown that students typically listen to podcasted lectures at home on personal computers, rather than MP3 players (e.g., Tynan and Colbran, 2006; Lane, 2006; Maag, 2006).

In terms of the ideal length of podcasts, Chan and colleagues suggest podcasts are no more than the average song that students listen to using their MP3 players (Chan and Lee 2005; Chan, Lee et al. 2006). However, Price et al. (2006) report that listeners of the popular *Slacker Astronomy* podcast think the original 5 minute segments are too short and request longer segments of around 20 minutes.

INTRODUCTION

This paper presents the findings of a preliminary podcasting pilot study held in the first half of 2007 within the Faculty of Economics and Business at the University of Sydney. The pilot study was conducted in order to develop a better understanding of how podcasting can be used to support students for student-centred learning. In addition, the study aimed to obtain a profile of the various types of students and their uses of podcasting, for example, revision, NESB, hearing impaired, replacement of lectures due to working.

The trial was undertaken in a postgraduate unit of study in the Masters of Commerce programme. The elective unit Business Marketing was chosen for the trial. This unit ran in intensive mode over three weekends and had an enrolment of thirty students. The choice was based on the large group of NESB students (over 70% were international students) in the class who in this unit have traditionally struggled with assessment tasks. The lecturer sensed that these students might have benefited from listening to the assessment guidelines and requirements more than once. Podcasting was therefore seen as a tool that may enhance their learning experience.

Prior to the start of the sessions, the lecturer recorded 5 podcasts of up to 15 minutes each. These podcasts contained information on the assessment tasks associated with the unit. These podcasts were then made available to students as a subscription or individual files via the unit's learning management system (Blackboard) site. Students were given instructions in the first session on how to subscribe to podcasts. The lecturers were provided with hands-on training on how to record and upload the audio-only episodes to their Blackboard site. Ongoing support was also provided throughout the trial to the lecturer.

This research sought to develop a better understanding of how podcasting could be used to enhance and support the student learning experience and impact the lecturers' teaching experience. Developing an understanding of the effect on learning and teaching will help to identify potential benefits for flexible learning.

METHODOLOGY

The research was carried out in several stages. The first stage involved administering a questionnaire to students in the first session of class. The aim of this survey was to gather information on students' familiarity and understanding of the concept of podcasting. It also allowed gathering information on students' expectations of podcasting in this context. Information was also collected on students' backgrounds (international or local) and gender. The second stage involved a questionnaire completed in the last session of class. This survey specifically gathered data on whether the students felt it enhanced their learning, allowed them to engage more actively in the class and/or supported their feedback on learning. The questionnaire also asked questions about where and how students listened to the podcasts.

At the end of class sessions, qualitative research was undertaken in the form of focus groups and semi-structured interviews with both students and the lecturer. This approach allowed for a more in-depth understanding of experiences and perceptions of the podcasting trial in this unit of study.

FINDINGS

Student understanding and use of podcasting

Students' understandings of podcasting were fairly limited, both before and after the trial. When asked to explain *podcast*, responses ranged from 'radio TV' to the more specific 'a downloadable sound file usually containing some kind of program or voice.' Prior to the trial, only half the students had downloaded a podcast and of these students, no one had made frequent use of podcasting.

While most students had an MP3 player (26 out of 30 students), most students listened to the podcasts on their own computers (26 students) and less than half listened to the podcasts on a portable MP3 player (12 students). This supports the research findings of Tynan & Colbran (2006), Lane (2006) and Maag (2006) who note that students prefer to listen to podcasts on their home computers. One student explained that even though MP3 players enable flexibility in listening to course content, if one wants to do well, one has to concentrate, so multitasking (implied where students are out being mobile while listening to podcasts) is not always an option.

In the pre-trial questionnaire, 29 of the 30 students indicate that they would like podcasting to be used in their units of study. In terms of when students would use the podcasts, their predictions before the trial differ somewhat to their responses in the post-trial questionnaire, as shown in Table 1.

	To prepare for class	After the lecture as the content was complex	After the lecture as English is not my first language	After the lecture as I have difficulty hearing	After the lecture for revision	To replace lectures so I don't have to attend	To prepare for assess-ments	Other
Pre-trial	20	19	17	10	21	7	18	3
Post-trial	8	15	14	7	20	1	14	1

Table 1: Student use (and expected use) of podcasting

Table 1 shows that fewer students used the podcasts to prepare for class than intended to (66.6% compared with 27%). However, we can also see that students listened to the podcasts after their lectures for various reasons, as they predicted. Additionally, approximately half the students listened to the podcasts to prepare for assessments, which was the purpose of the podcasts, and only one student used it to replace lectures.

Student perceptions of podcasting

After the trial, the students were evaluated on their perceptions of podcasting, as shown in Table 2.

	Strongly agree/ agree	Strongly disagree/ disagree	Not applicable
Podcasting supported or enhanced my learning	96%	0	4%
Podcasting helped me actively engage with learning	89%	0	11%
I like podcasting because I can learn in my own time	96%	0	4%
I would like to see podcasting used in more of my units of study	100%	0	0

Table 2: Student perceptions of podcasting
From Table 2 we can see that the students were overwhelmingly positive in their evaluations of podcasting and would like further use of podcasting in their studies. One student noted, "Although I think this is a good idea, I did not have time to use these as the course was intensive and I am extremely busy", which may account for most of the 'not applicable' responses.
Lecturer perceptions of podcasting

For the lecturer, the benefits of using podcasting were reinforcing information given to students in the lecture about assessment and saving time after the lecture answering student queries about the assessment requirements. The lecturer reported, "The biggest plus for me was writing shorter emails because I was able to just send them to the podcast and say, 'The information is there, you just need to listen to it.'" In future the lecturer is keen to use podcasting for a wider range of uses, including recording of lectures, feedback on assessment and summaries of readings.

The lecturer believes that podcasting demonstrates a teacher's interest in their students and said, "*Once you have shown them that, they tend to get more engaged with the subject. Because they tend to think, 'Well, here is a lecturer who is actually interested in what I am learning and how I am learning it.*'" The lecturer also reported on students' interest in podcasting and said, "*When I brought it in to record they were all really excited about the whole thing and they were saying it is something that universities should be doing more… Not all of them used it but those who did really seemed to enjoy it and liked the concept of being able to go back and check stuff.*"
An additional benefit of podcasting is its usefulness for students whose first language is not English. The lecturer said, "*I am facing students who are really struggling with English and being able to podcast means… they can go home, they can listen to it over and over again until they get the concepts. And it means you are not having to slow down the class to cater to those students because that is what tends to happen, I have to start slowing things down because you know they are not picking it up and if they don't pick it up then they are going to fail.*"
Because of its usefulness for the high percentage of international students in the faculty, the lecturer thinks podcasting should be supported at a faculty level.

CONCLUSIONS
This paper presents the preliminary findings from a study on the impact of podcasting on student learning and a lecturer's perceptions of the benefits of using podcasts for teaching.
In theory, the concept of podcasting appears to provide an answer to embedding flexible learning to support the student learning experience. Findings from the research suggest that students do feel they obtain learning benefits from the use of podcasting with 96% saying podcasting enhanced their learning and 89% stating podcasting helped them actively engage in learning. In terms of flexible learning, 96% of students liked the fact they could be supported to learn in their own time.

What is highlighted from our findings and is supported by other studies (e.g., Tynan and Colbran, 2006; Lane, 2006; Maag, 2006) is that students use their home computers to listen to podcasts using the native audio player, as opposed to loading the podcasts on to their portable MP3 players and listening in other locations (e.g., on the bus or train to university). It appears then that students are not taking advantage of the ability to use *dead time* (Bull 2005; Chan *et al.* 2006) to gain broader benefits from flexible learning. As mentioned earlier, one student's statement may provide an answer: "in order to do well, one has to concentrate, so multitasking is not always an option". As over 70% of students in this case are NESB, the need to concentrate to develop a better understanding may well be a key factor in the learning process.

Therefore, it may be that if we are going to take advantage of the opportunities afforded by podcasting, we need to investigate the appropriate types of podcasts, why they are being used, where the most appropriate location for listening is, and how they would best be used by students to improve their learning. In the second half of 2007 further investigations will be conducted to answer these questions.

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ASSESSMENT OF MLEARNING A CASE STUDY: ASSUMPTION UNIVERSITY OF THAILAND

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ABSTRACT

This paper is based on the research done during October-December 2006 at Assumption University of Thailand to assess the needs and requirements of students in using mobile devices to augment their traditional studies at the university and also to study the attitudes of the lecturers and the university towards mobile learning (mLearning). The research shows a positive attitude towards mLearning by all stakeholders and it examines the methods and cost associated in production of mLearning material.

Author Keywords

INTRODUCTION

Assumption University is the first international university in Thailand. Fully accredited as an institution of higher learning by the Ministry of Education in Thailand, it currently serves about 19,000 undergraduate and graduate students from more than 60 countries. The University is a non-profit institution administered by the Brothers of St. Gabriel, a worldwide Catholic religious order, founded in France in 1705 by St. Louis Marie De Montfort, devoted to education and philanthropic activities. The congregation has been operating many educational institutions in Thailand since 1901 (Assumption University, 2007). The College of Internet Distance Education (CIDE) was established in 2002 as a semi-autonomous organization within Assumption University whose purpose is to provide Internet based eLearning programs to Thai students and those in neighboring countries. Currently it offers 2 master degree programs in Management and ICT, and a Ph.D. program in eLearning Methodology (College of Internet Distance Education, 2007). CIDE uses Moodle as the main Learning Management System (LMS) for the eLearning programs. Video of lecturers teaching the courses in various programs are taken in the College studio and after post-production, these video files are stored on the College server alongside other teaching materials as the learning resources accessible through Moodle. Graduate students registered for a given course could access and view the course video on their PCs or notebooks anywhere in the world using video streaming technology. The MP3 audio lectures have been very popular because students are able to download them and listen to them on their MP3 players or smart mobile phones practically anywhere.

In a survey conducted in May 2006, CIDE students considered the MP3 audio lectures to be the second most important learning tool after the video lectures. As a result of this survey, the author considered the introduction of MP3 audio files, or even videos of lectures, to the programs of traditional students to supplement attendance at class. Given the ability of today's pocket phones and PDAs to connect us to a variety of information sources and enable communication nearly everywhere we go, mobile technologies may gradually come to extend beyond from occasional supplemental use on accessed through desktop computers; frequent and integral use of personal mobile technologies (Soloway et al., 2001) to augment physical and situated learning may become an important part of the education of the near future (Roschelle & Pea, 2002).

Mobile devices allow access and use of learning materials almost at any location which indeed enhances the concept of asynchronous eLearning by definition of "anytime" and specially "anyplace". Ally (Ally, 2004) defined mLearning as the delivery of electronic learning material on mobile computing devices to allow access from anywhere and at anytime. As the prices of mobile devices such as MP3 players, smart mobile phones, PDAs, and notebooks are dropping, more and more students could afford to own one of these devices. Many varieties of mobile devices have easy access to the Internet either using GPRS or WiFi (Wireless ieee 802.11 b/g) technologies. Many of these mobile devices can play audio files in MP3 format or video files in flash or Windows media player format. These devices could become ideal tutoring tools for students to listen or watch the audio and video lectures again and again to improve their understanding of the class lectures when audios of the lectures are recorded or videos of the lectures are taken.

Most students of Assumption University are from middle class and higher income families who own some sort of MP3 player or a smart phone/PDA capable of playing MP3 files. The purpose of this research was to determine the need and usefulness of such mobile devices in students' studies at the university.

RESEARCH ANALYSIS

In order to determine the attitudes of students enrolled in programs using traditional on-campus classes towards the use of mobile devices in their studies, a survey was prepared and posted on the student portal of the Assumption University web site (www.au.edu) in October 2006. An email was sent to all the students of the University explaining the purpose of the survey and asking them to go to the URL of the web page to complete the questionnaire. Within one month after the emails were sent, 145 students replied. The questions an responses are as follows:

- 72 of respondents were male and 73 of them females.
- 7.59% of respondents were graduate students and 92.41% of them undergraduates.
- The respondents represented 9 faculties of the University; the greatest numbers of respondents were from the faculty of Business Administration and faculty of Business Arts, the two largest faculties of Assumption University.
- 142 out of 145 or almost 98% of respondents own an MP3 player or a mobile device capable of playing MP3 files. 77 of them or 53% of the respondents had mobile devices capable of playing video files in addition to audio files.
- The most prevalent OS of the mobile devices, 25%, was Symbian; 12% used Windows mobile; the majority, however, did not know the operating system of their devices or simply reported that they were using plain MP3 players.
- The screen sizes of the mobile devices
  - ➢ 1 - 1.99 inches : 24%
  - ➢ 2 - 2.99 inches : 61%
  - ➢ 3 - 3.99 inches : 13%
  - ➢ 4 - 4.99 inches : 3%
  - ➢ 5 inches or more : 1%
- SMS, listening to music, playing games, and browsing were the highest ranked activities for which mobile devices were used.
- Most of the respondents use their mobile devices many times a day for other tasks rather than making phone calls and spend more than one hour a day on the tasks.
- The majority of participants considered the purchasing cost of these smart mobile devices or the cost of being online (GPRS, WiFi) as the main drawback in using their gadgets. They did not consider the small size of screens or lack of keyboards as problematic factors.
- The participants considered the followings as the most important features that could contribute to their studies, if they were to be implemented for mobile devices.
  - ➢ Receiving SMS from the university about news and announcements.
  - ➢ Watching video lectures on their mobile devices.
  - ➢ Listening to MP3 audio of the lectures.
- 79% of students indicated their willingness to purchase a smart mobile phone or PDA if their existing mobile devices could not play the video/audio files of the lectures.
- There was no significant difference in the attitudes of male and female students towards the use of their mobile devices for listening or watching the lectures; neither was there any significance difference in the attitudes of students in various faculties towards mobile learning.
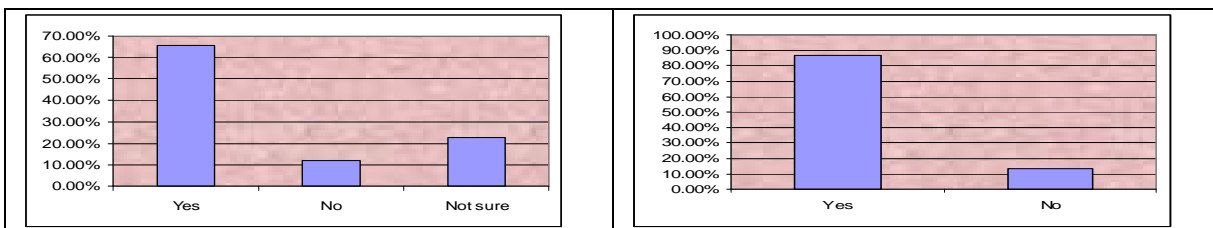
Figure 1. Do you think mobile devices can play a useful and effective role in your studies?	*Figure 2. Would it help your studies if the video of the lectures become available for mobile devices?*
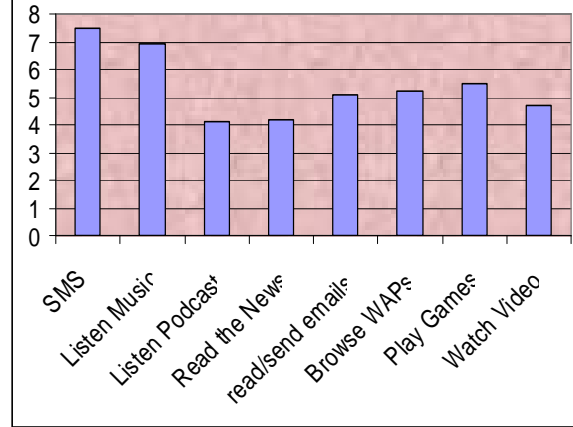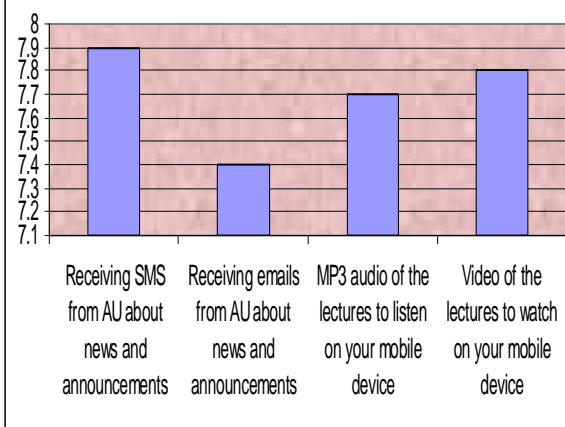
Figure 3. Ranking of the usefulness of the features if implemented on mobile devices (1 = the least useful, 10 = the most useful) .	**Figure 4. Ranking of the features of your mobile device that you use the most (1 = the lowest rank, 10 = the highest rank).**

From the Figures 1 through 4 which are parts of the questionnaire, it is clear that majority of students have a positive attitude towards mobile learning. They believe that watching the video or listening to a lecture on their mobile devices would certainly improve their studies and understanding of the subject in a better way. They indicated that they would be willing to pay a reasonable amount of money to gain access to such services.

TEACHERS' ATTITUDE TOWARDS MOBILE LEARNING

After the questionnaires from students were collected, lecturers from various faculties of the university were informally interviewed during November and December 2006. The purpose of the informal interview was to determine their attitude towards mobile learning. A total number of 17 lecturers, 11 male and 6 female, aged between 28 and 54, were interviewed and part of the data obtained from this process is shown below:

- One lecturer just uses transparencies for giving the lectures. The lecturer does not use any sort of electronic media.
- Sixteen use some form of electronic media, such as PowerPoint to conduct their lectures.
- Three lecturers use open source Moodle installed at the one of the university's servers to provide more information in electronic format to students and receiving questions and assignments through Moodle in addition to the use of PowerPoint.
- One of the three who use Moodle also provides a video lecture of his classes on VCDs which students can borrow from the library.

The lecturers were asked whether they would mind if the audio/visual department of the University recorded the activities in their classes on video or audio taped their lectures and then after editing of the recorded material to store on a server at the University for their students to download to watch or listen using their mobile devices. Here are their responses:

- Eleven had strong reservation against either video or audio recording   their lectures.
- Six other lecturers had a more limited and more moderate reservation.
- Only one lecturer had a positive attitude towards the audio or video recording of his classrooms lectures.

The reservations expressed by the lecturers were as follows:
- A lack of a strong copyright law in Thailand.

- The question of whether the copyright ownership of the recoded media would be owned by the lecturer or the university.
- A worry that the recorded lectures could be used by deans or administrators of the university to judge the teaching performance.
- The feeling that greater preparation would be needed to make lectures suitable for recording.
- A few indicated that they are camera shy and fear they could not give a good lecture when being video/audio taped.

Lecturers were asked whether they would accept to be video/audio taped if the university provides an adequate compensation for their participation in the mLearning project and providing the recorded media for their students to download. Below are their comments:
- Fifteen of the lecturers showed a willingness to be audio taped if the compensation is satisfactory.
- Eleven indicated they would be willing to be videotaped with adequate compensation..

These informal interviews suggest that a majority of lecturers may be willing to participate in an mLearning project that will benefit students as long as financial compensation is provided to them. More lecturers prefer audio recording to video recording and demand more compensation for video recording.

THE UNIVERSITY ATTITUDE TOWARDS MOBILE LEARNING
Assumption University has been very supportive of providing faculty and students with the latest technologies that could be used in the teaching and learning process. In 1993, AU was the first university in Thailand to provide, for a fee of US$ 5.00 per month, full Internet access to all the students both on-campus and of-campus through 800 telephone lines (Charmonman & Anaraki). Being a non-profit organization, the University invested this income to enhance the networking infrastructure in the University and to provide PCs with the Internet access at all classrooms, offices, and labs for the students and faculty. Starting 2003, AU has also initiated installing wireless access points at various locations in two campuses of the university to provide wireless Internet access to the students and faculty anywhere in two campuses. The College of Internet Distance Education was set up in 2002 to provide Internet-based education which is growing through these years and has been proven to be successful. The College provides the MP3 audio of the lectures to students and plans to prepare the flash video version of the video lectures and to provide them to students for watching on their smart mobile phones and PDAs. The university and the College top executives believe in importance of mobile learning in education.

It would be costly to provide mLearning material for students. The cost of recording the audio of the lecturers and converting them to MP3 format and storing them on the university's server for the students to download is much cheaper than the cost of video taping the lecturers, editing and rendering the video tapes and converting them to a format like Flash for mobile device. The university could provide the MP3 audio and video ready format of the lectures and sell the media to students on a download basis.

In the survey conducted, as shown in Figure 4, the participants ranked receiving the SMS from the University about news and announcement as the most important feature for their studies. The respondents use the SMS feature of their mobile devices most frequently. Most students are familiar with sending and receiving SMS and know the importance of receiving SMS from the University about the news and announcement. Currently the University announces the news such as cancellation of classes, exam schedules, exam rooms and seat arrangements, and other news of importance to students on the University website. With some investment, the University could provide the service of sending all the relevant news to the right students through SMS service. The students could subscribe for such a service with a small fee. Such a service has already been utilized in a number of universities with a good satisfaction (Divitini et al., 2002).

CONCLUSION

A number of studies concerning mobile learning have shown the positive potential of the use of mobile devices for student studies. The cost involved in producing audio MP3 files or video files for smart mobile phones or PDAs could be partly paid by students and partly by the university. If the high cost is a major issue, the project could be started with less expensive MP3 audio recording. The author of this study plans to continue the research by making it possible for MP3 audio lectures to be prepared for several classes and measuring the impact of these audio recordings on the academic success of the students in class

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