Mobile learning – a new paradigm shift in distance education?

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Those who do not remember the past are condemned to repeat it.
(George Santayana, 1863-1952)

Abstract

During recent years, many distance teaching as well as residential institutions have started to experiment with mobile learning through pilot projects as part of their e-learning and technology enhanced learning environments. Mobile learning should not be regarded as a medium for distance learning. However, because of the similar affordances of distance learning technologies and online and mobile learning, the established field of distance education can provide valuable insight into strategies, approaches and practical experiences with regard to the conception and organization of this new medium for learning. Distance teaching institutions have a long history and much experience with media-based instruction. This affords them an advantage in the development and application of new information and communication technologies (ICTs) for teaching and learning. Student support systems have existed in traditional distance education for decades. ICTs – especially mobile devices – open up new paths for learning support and opportunities to reach a wider audience for (higher) education. However, will mobile learning bring about a paradigm shift in distance education? Or is it perhaps a new generation of distance education? Does it afford new opportunities for teaching and learning in terms of access and flexibility? This paper reports on an international survey that was conducted amongst distance educators in order to explore these questions.

Contents

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1 Introduction

Mobile learning is in many ways a new phenomenon and its theoretical, pedagogical, organizational and technical structure is currently still developing (Brown, 2004). Many distance teaching as well as residential institutions have already started to experiment with mobile learning through pilot projects as part of their e-learning and information and communication technology (ICT) enhanced learning environments. Because of the similarities between distance educations, online and mobile learning, the established field of distance education can provide valuable insight into strategies, approaches and practical experiences with regard to the conception and organization of this new medium for learning. Distance education can review over 150 years of experience with media-based instruction (Gladieux & Swail, 1999): "Today's virtual instruction has its roots in correspondence schools" (p. 9). Distance teaching institutions are therefore at a clear advantage in the development and application of new ICTs for teaching and learning. However, it can be observed that many speakers at conferences or vendors of cutting-edge technologies often neglect the link between new ICT tools or devices and the lessons learnt in distance education, which have to be considered in order to avoid mistakes from the past.

The experience of distance education shows that learning support for students is of decisive importance for successful distance study (Brindley & Paul, 1996; Zawacki-Richter, 2004). Student support systems in various forms have existed in traditional distance education for decades. ICTs – especially mobile devices – open up new paths for learning support and opportunities to reach a wider audience for (higher) education.

In the light of the above pattern of thought, does the emergence of mobile learning imply a new generation in distance education or even an educational paradigm shift? Does it afford new opportunities for teaching and learning in terms of access and flexibility? The aim of this paper is to explore mobile learning as a new field of pedagogical activity.

Development rising arisen

2 From print to wireless

2.1 The emerging concept of mobile learning

Landline telephones and wired computers are beginning to be replaced by wireless technologies. Desmond Keegan emphasized in his keynote address at the World Conference on Mobile Learning 2005 in Cape Town that "The future is wireless. […] Never in the history of the use of technology in education has there been a technology that was as available to citizens as mobile telephony. The statistics are stunning: Ericsson and Nokia tell us there are 1.5 billion of them in the world today for a world population of just over 6 billion. Nokia forecasts further sales of 700 million in 2005. In China alone there are 358 million mobile subscriptions and these are reported to grow by 160.000 a day (p. 3). Seventy seven percent of the world's population is within reach of a mobile phone network (Kukulska-Hulme & Traxler, 2005).

Because of the lack of infrastructure for ICTs in developing countries (for example, cabling for the Internet and telecommunications), the growth of wireless infrastructure is developing even more rapidly. Between 1997 and 2001, the number of mobile phone subscribers in Africa for example, had an annual triple-digit growth rate (Shapshak, 2002). In 1999 Tokyo had more telecom connections than the whole of Africa combined, yet by 2003 Africa had twice as many as Tokyo (Gourley, 2004). Mobile subscribers in Africa increased by over 1000 % between 1998 and 2003, to reach 51.8 million (ITU, 2004).

Educators started experimenting with wireless and mobile technologies from the turn of the millennium and the concept of mobile learning began to emerge. There is currently globally a rapid rate of development and application of wireless and mobile technologies in contemporary learning environments and learning paradigms. Apart from mobile phones, other wireless and mobile computational devices such as laptops, palmtops, PDAs (Personal Digital Assistants) and tablets also rapidly entered the market – some devices, of course, have exhibited more success than others for particular markets. Keegan (2003) presents and analyses no less than 30 mobile learning initiatives across the globe in 2001. In such initiatives much has already been done about the experimental use of

wireless technologies (including wireless Internet environments and wireless classrooms) and various mobile devices for teaching and learning. Kukulska-Hulme and Traxler (2005) provide a dozen detailed case studies that report on the experiences of pioneer educators around the world who have experimented with mobile technologies in universities and colleges and in commercial training. They explore user experience with mobile devices, accessibility, pedagogical and institutional change, and current technology. With regard to the potential of mobile learning in developing countries, Brown (2004) argues that Africa is leapfrogging from an unwired, (almost) non-existent e-learning infrastructure, to a wireless e-learning infrastructure. There are already many mobile learning activities and projects in Africa – from the use of PDAs in assessment strategies (e.g. the clinical assessment of medical students) and PDAs in wireless learning environments (e.g. engineering students for collaboration and coursework) to the use of the most basic mobile texting functionality (SMS) for learning support (Brown, 2006).

2.2 Mobile learning in the context of distance education and flexible learning

Over the past decade we have become familiar with the term 'e-learning' and now the concept of 'mobile learning' is emerging. What then, is the relation between the two notions?

The all-inclusive umbrella term for media-based learning and teaching is distance education or distance learning, which is characterized by "the quasi-permanent separation of teacher and learner throughout the length of the learning process" (Keegan, 1986, p. 49). The central concern of distance teaching pedagogy is to bridge the distance: "Because the distance to students was regarded as a deficit, and proximity as desirable and necessary, the first pedagogic approaches specific to distance education aimed immediately at finding ways by which the spatial distance could be bridged, reduced or even eliminated" (Peters, 2001, p. 18). E- and mobile learning provide enormous possibilities for closing the gap between learners and teachers or the teaching institution, to overcome the misconception of distance learning as an isolated form of learning.

In general, e-learning means learning with electronic media, i.e. via the Internet (intranet or extranet), but also via television and radio, audio and video tapes and CD-ROM. E-learning is therefore defined more narrowly than distance learning, which includes print-based study materials and correspondence communication. E-learning can therefore be regarded as a subset of distance learning, but not vice versa (Rosenberg, 2001). The printed materials which are widespread in distance learning should be understood here as a form of technology as well. The following comprehensive definition of Urdan and Weggen (2000) provides a sufficient basis to distinguish between mobile learning and e-learning: "The term e-learning covers a wide set of applications and processes, including computer-based learning, Web-based learning, virtual classrooms and digital collaboration. We define e-learning as the delivery of content [and interaction] via all electronic media, including the Internet, intranets, extranets, satellite broadcast, audio/video tape, interactive TV, and CD-ROM. Yet, e-learning is defined more narrowly than distance learning, which would include text-based learning and courses conducted via written correspondence" (p. 8).

Mobile learning can be viewed as a subset of e-learning. E-learning is the macro concept that includes online and mobile learning environments. Online learning facilitates communication and collaboration via networked computers.

For the purpose of this paper we conceptualize mobile learning as a subset of e-learning; that is, e-learning is the macro concept that includes online and mobile learning environments. In this regard the following simple definition by Quin (2001) is useful: "M-learning is e-learning through mobile computational devices" (p. 1). Mobile learning devices are defined as handheld devices and can take the form of personal digital assistants, mobile phones, smartphones, audio players (such as the Apple iPod), video and multimedia players, handheld computers and even wearable devices. They should be connected wirelessly, thus ensuring mobility and flexibility. They can be stand-alone and possibly synchronized periodically, intermittently connected to a network, or always connected (adapted from http://www.mlearnopedia.com/index.html).

The extended opportunities for communication and interaction afforded by the new media lead to a convergence of the pedagogic structures for distance learning and campus-based face-to-face learning with regard to support for learners and the practice of teaching and learning (Mills & Tait, 1999; Collis

& Moonen, 2001). More and more universities are offering courses in which phases of face-to-face teaching alternate with guided online studying. In this context, terms such as 'blended learning' (Sauter & Sauter, 2002), 'flexible learning' (Collis & Moonen, 2001) or 'distributed learning' (Lea & Nicoll, 2002) are becoming prevalent. A continuum is coming into existence between the two poles of campus-based and distance learning.

Brown (1999) describes flexible learning as "a macro concept and education philosophy that focuses on student centredness, learning centredness and flexibility in terms of learning environments and learning opportunities. The international trend is that successful and effective tertiary education is linked to the creation of student-centred flexible learning environments that provide for flexibility in terms of: access to and exit from several learning programmes; accreditation and portability of qualifications; modes in which education takes place; modes in which communication and interaction take place; programme compilation; study material; evaluation and assessment methods; time and place of study; and pace at which learning takes place. [...] [Flexible learning] refers to a mixed or multimode of education that includes all modes of contact and distance education, as well as all possible combinations thereof" (p. 1).

Figure 1 visually portrays the relation between mobile learning, e-learning, distance learning and flexible learning.

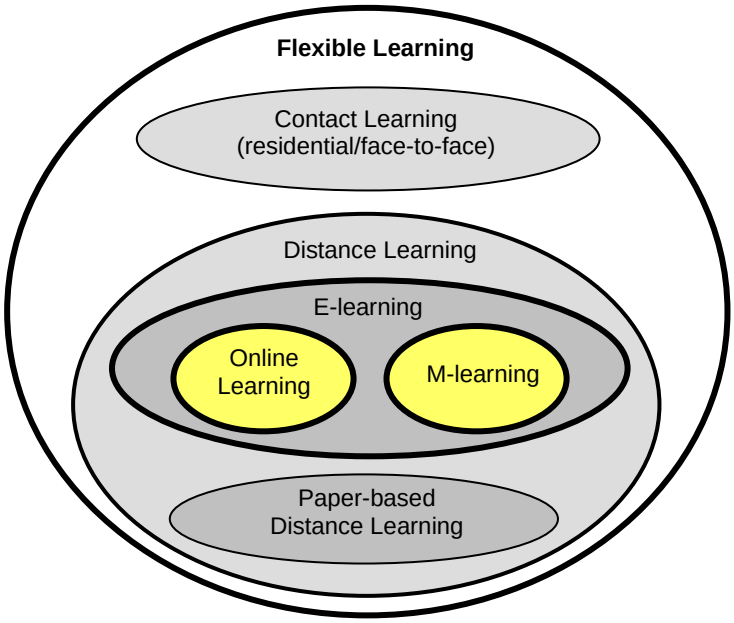

Figure 1: The subsets of flexible learning (Brown, 2005)

2.3 Generations of technological innovations in distance education

To further explore opportunities that mobile learning affords, we have to build upon previous generations of technological innovations, in order to benefit from the lessons learnt in distance education.

Garrison (1985) distinguishes three generations of technological innovations that initiated a paradigm shift in distance education. The term 'paradigm shift' in education refers to the changes in teaching and learning as a consequence of the tremendous impact of technological advances (Peters, 2004): "A paradigm shift in education might mean that in education certain models or patterns no longer exist, because new models and patterns which differ from the old ones in a marked way have substituted them. This means that, very often, we are not dealing with a transitory process in the field of education under investigation but with a sudden, if not with an abrupt change" (p. 25).

Media are described by Garrison (1985) as a function of interaction and independence. He identifies three milestones of technological innovations, namely print media (correspondence generation), telecommunication technologies (telecommunications generation) and the personal computer

(computer generation). Other media that are not considered to have significantly altered the delivery of distance education are so-called ancillary media, e.g. radio and television broadcasts, audio or video cassettes. Such media are not capable of providing two-way communication, which is widely accepted as a constituent element of distance education (cf. Keegan, 1986).

Garrison's generations are an established concept that has been further developed with the emergence of new media, especially the Internet, since the 1980s by other authors such as Nipper (1989), Taylor (1995), Taylor (2001) or Srivastava and Reddy (2002). The term 'generation' has been criticized since it implies the end of one phase and the beginning of another. However in distance education, an 'old' generation does not fade out, but technological advancements build upon each other to open new channels of learner support and two-way communication.

Access, flexibility and costs have been described by Daniel (1998) as major attributes of distance education. Distance education is capable of offering access to education for high numbers of students, independent of time and space, at low costs through economies of scale (mass higher education). Hülsmann (2000) highlights the economic strength of open and distance learning: "Distance education is associated with comparatively higher fixed costs and lower variable costs. It needs more substantial investment up front for course development but these costs are then spread over an increasing number of students. […] As student numbers increase, so the fixed costs can be shared among an ever-growing number of learners, thus gradually reducing the average cost per student. Provided that the variable costs of distance education – for tutoring or the distribution of materials in particular – can be held down, it may therefore bring economies of scale" (p.30).

The media applied in distance learning influence the form and nature of interaction and communication, the level of independence and flexibility, as well as scalability and therefore access and costs of distance learning courses.

In the following sections we analyse the development of distance education according to Garrison's (1985) three generations with regard to the attributes emphasized above:

- Correspondence generation (since the 1850s),
- Telecommunications or Open University (OU) generation (since the 1960/70s), and
- World Wide Web (WWW) generation (since the 1990s).

2.3.1 Correspondence generation

The roots of distance education date back over 250 years. The first generation was print-based correspondence education. Battenberg (1971, p. 44) mentions the 'lessons' advertised in the Boston Gazette in 1728 by Caleb Philipps as the first milestone in distance education. In Europe, Gustav Langenscheidt founded his publishing house in 1856 and, together with his colleague Charles Toussaint, offered self study language courses in French. These lessons became famous because of the phonetic alphabet (méthode Langenscheidt-Toussaint) that was developed to teach French pronunciation via print-based study materials. Strictly – according to the criteria defined by Keegan (1986) – these early forms of correspondence courses cannot be considered as distance education because of their non-interactiveness. Two-way communication (i.e. tutorial support via letters) is known from the Institute of Correspondence Education (Abteilung für brieflichen Unterricht) of Simon Müller in 1897 in Berlin (Delling, 1992, see Figure 2).

The University of London was the first university that offered correspondence courses in 1858 for emigrants in the colonies of the British Empire. Effective learner support was non-existent: study materials were simply sent off via a post ship, together with a syllabus and a list of examination places and dates (Ryan, 2001): "It left any 'learning' to the hapless student, who sat the examination whenever he or she felt ready: a truly 'flexible' schedule!" (p. 71). The first dedicated distance teaching university was founded in 1875: the University of South Africa (UNISA) in Pretoria.

Correspondence education afforded maximized flexibility and access through independence of time and space. However, the autonomous, self-directed learner does not exist per se. Therefore, the dominant one-way communication, i.e. the dispatch of pre-prepared study materials, was supplemented by two-way communication, e.g. by means of face-to-face sessions, tutoring via letters, or the telephone. However, the opportunities for, and effectiveness of learner support were limited.

Response times were long, since communication depended on the postal system via railway or post ships.

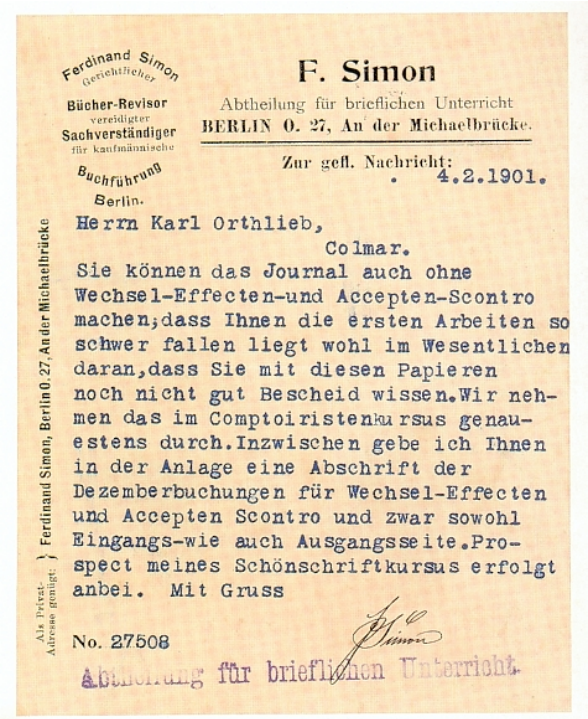

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Figure 2: Tutoring in correspondence education in 1901 (Delling, 1992)

Print-based distance learning is still the most prevalent form of distance education, because the mega-universities with several hundred thousand students (Daniel, 1996) rely on the scalability of print-based distance education (mass higher education). Furthermore, print-based distance education is the only possible way to reach target groups (e.g. learners in rural Africa) that have no access to a computer or e-mail.

First generation distance education was characterized by limited and extremely slow interaction (two-way communication via letters). Contact with other learners was only possible through contact sessions and therefore almost impossible for most students.

2.3.2 Telecommunications or OU generation

The second generation in the development of distance education is closely linked with the foundation of Open Universities in the late 1960s and early 1970s, e.g. the Open University UK in 1969, which serves as a model in this field. Dedicated distance teaching institutions applied instructional design methods systematically to produce sophisticated, high quality study materials (cf. Schreiber, 1998).

Another new development in second generation distance education was the establishment of study centres as an important element of the student support system (Tait, 2000). Such centres provide access to educational technologies such as video-conferencing, study materials, library services, learning groups and personal counselling (Tait, 1995).

Telecommunications and electronic media facilitate communication in terms of audio, video and text information via telephone, fax, television, video, radio as well as audio-, video- and computer-conferencing. The telecommunications generation is therefore also called 'multimedia distance teaching' (Nipper, 1989).

Garrison (1985) emphasizes the importance of computer assisted learning (CAL). CAL programmes are self study materials that should maximize interaction and independence. In this regard, interaction is seen as a form of internal interaction, i.e. between the computer-based learning programme and the learner: "Consideration of CAL's potential in distance education requires going beyond the restrictive

view that interaction is mediated person to person communication" (p. 238). However, experience has shown that programmed instruction without social interaction and dialogue between learners and teachers, and among learners, is not very successful (cf. Schulmeister, 1999; Wessner, 2001). CAL programmes can, however, be a meaningful supplement to the distance education package.

In an audio- or video-conferencing, learners can communicate synchronously. Long response times, as in correspondence education, are reduced dramatically. However, the technology requires a great deal of expensive equipment that has to be provided by a local study centre, which means that students cannot participate without visiting the study centre at a fixed time. Therefore, access and flexibility are limited. Daniel (1998) even speaks of a triple crisis of access, cost and flexibility: "Group teaching in front of remote TV screens? This is not only an awful way to undertake distance learning, but flies in the face of everything that we have learned while conducting successful open and supported learning on a massive scale for the past 27 years. Our lessons are the key to addressing the triple crisis of access, cost and flexibility now facing higher education world-wide" (p. 21).

2.3.3 WWW generation

Murray Turoff from the New Jersey Institute of Technology developed computer-mediated communication (CMC) and the CMC-based learning environment 'Virtual Classroom' (Turoff, 1995; Hiltz, 1995). At the Open University UK the 'CoSy' (conferencing system) was introduced for online tutorials as early as 1988 (Mason, 1989). Today, powerful learning management systems have emerged from those early forms of CMC systems.

The big breakthrough of CMC was facilitated through the massive distribution of personal computers and the development of the World Wide Web in the 1990s. Access to information and communication independent of time and space became possible through the availability of networked computers – in this way interaction and independence were reconciled with each other.

Isolation has been seen as a major problem in distance education (Brindley & Paul, 1996): "Distance learning can be very isolating, and inadequate attention to course design, student counseling and support can yield poor completion rates and the worst aspects of one-way knowledge transmission" (p. 43). The most valuable benefits that modern ICTs can bring to distance education are flexible, inter-personal two-way communication and tools for collaborative learning: "The availability of learners to each other and to the tutor asynchronously as well as synchronously, has the potential to overturn the emphasis on distance education as an individualized form of learning" (Thorpe, 2002, p. 114). The issue of access to synchronous audio- and video-conferencing mentioned under second generation distance education can nowadays be solved through virtual classrooms such as Centra or Macromedia Breeze, where various synchronous and asynchronous communication and presentation media converge in one web-based learning environment.

In contrast to CMC as an add-on to learner support, in the wholly integrated online teaching model (Thorpe, 2001), "the tutors of the course carry authority to create the detailed course teaching as it progresses over the duration of the course, rather in the way a conventional university lecturer does" (p. 17). Tutors must not only be subject matter experts, but they also need more advanced skills in online communication and moderation than the conventional tutor in a second generation distance education course. A possible drawback of such interactive online courses that are facilitated by subject matter experts or moderated by online tutors or 'e-moderators' (Salmon, 2000), is limited scalability. The advantage of lower initial production costs of such courses is dissipated by higher course presentation costs (tutoring).

Taylor (2001) seeks to solve the cost dilemma with intelligent automated tutor systems in his fifth generation: "In contrast, fifth generation distance education has the potential to decrease significantly the costs associated with providing access to institutional processes and online tuition. Through the development and implementation of automated courseware production systems, automated pedagogical advice systems, and automated business systems [...]" (p. 4). However, learner support via computer-generated automated feedback reminds us of programmed instruction, which proved not to be very successful, especially for higher order learning. Furthermore, the status of research in artificial intelligence remains far from ready for the application for tutorial feedback systems in practice.

2.4 Mobile learning: the next generation?

Soloway (2003) remarked that: "For the first time in ICT history, we have the right time, the right place and the right idea to have a huge impact on education: handheld computing" (p. 2). The increased access to mobile technological devices, the availability of support systems and the need for communication paved the way for learning to be available anytime, everywhere. The following are some possible examples – by no means comprehensive – of the rich opportunities that mobile technologies provide to enhance distance learning environments:

- Mobile learning provides more mobility, flexibility and convenience than online learning. Because of the ubiquitous and pervasive nature of mobile devices, it can also be more spontaneous, situated (authentic) and explorative.
- Life-long learning demands 'learn while you earn', which becomes possible through e-learning. Mobile learning takes it further and makes it possible to 'learn while you earn on-the-go'.
- MMS (multimedia messaging system) makes it possible to deliver and receive multimedia content such as audio, images and video sequences.
- m-LMSs (Learning Management Systems for mobile learning) are already starting to emerge.
- Interoperability with e-mail and the Internet is a key factor for new developments.
- Integrating EPSS (Electronic Performance Support Systems) into the mobile environment will take mobile learning even further: mobile learning with on-demand access to information, tools, learning feedback, advice, support, learning materials, etc.

Kukulska-Hulme and Traxler (2005b) summarize the affordances of mobile technologies for learning and teaching as follows: They "[…] open up new opportunities for independent investigations, practical fieldwork, professional updating and on-the-spot access to knowledge. They can also provide the mechanism for improved individual learner support and guidance, and for more efficient course administration and management" (p. 26).

But do mobile technologies lead to a new quality of teaching and learning in terms of interaction and independence, access, flexibility and costs so that it might be appropriate to speak of a new generation of distance education or an 'educational paradigm shift' in the sense of Peters (2004)?

3 Results of survey: What do distance educators think about mobile learning?

In order to address this open question, the authors conducted an international survey amongst distance educators. The questionnaire was distributed by Carl von Ossietzky University of Oldenburg (Center for Distance Education) in cooperation with HfB - Business School of Finance & Management (Frankfurt) in Germany and the University of Pretoria – Department for Education Innovation (South Africa).[4] The following themes were investigated:

- mobile learning and teaching experience of distance educators,
- the development and growth of mobile learning,
- the impact of mobile technologies on teaching and learning,
- mobile learning applications and mobile learning activities,
- mobile learning and access to (higher) education,
- the future development of mobile learning.

The survey was distributed via professional distance education networks like the European Distance Learning and E-Learning Network (EDEN), the South African Institute for Distance Education (SAIDE), and the Canadian Association for Distance Education (CADE). It was also sent to faculty and alumni of the Master of Distance Education programme at the University of Maryland University College (UMUC) in the U.S. Within two months the authors received 88 responses from 27 countries.

[4] The questionnaire resides at: http://www.webropol.com/P.aspx?id=99123&cid=21011649

3.1 Who responded?

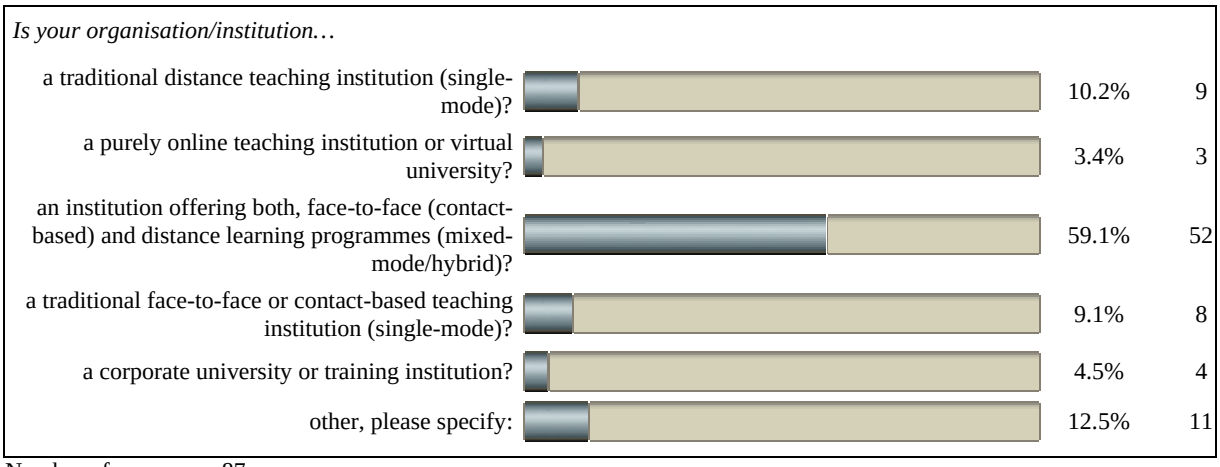
The following table provides information on the countries of origin and the number of respondents.

Table 1: Numbers of respondents from different countries

Country	Responses
Albania	1
Australia	2
Austria	1
Barbados	1
Canada	9
Colombia	2
Cyprus	1
Finland	1
France	1
Georgia	1
Germany	15
Great Britain	8
Hungary	1
Ireland	3

Country	Responses
Israel	1
Lativa	1
Malta	1
Mexico	1
Netherlands	3
Norway	1
Portugal	1
Romania	1
South Africa	15
Sweden	1
Switzerland	1
Turkey	2
USA	12
Total	**88**

The highest percentage of respondents (59,1 %) were from institutions that offer both face-to-face (contact-based) and distance learning programmes (mixed-mode/hybrid). Figure 3 depicts the distribution of respondents amongst defined higher education institution types.

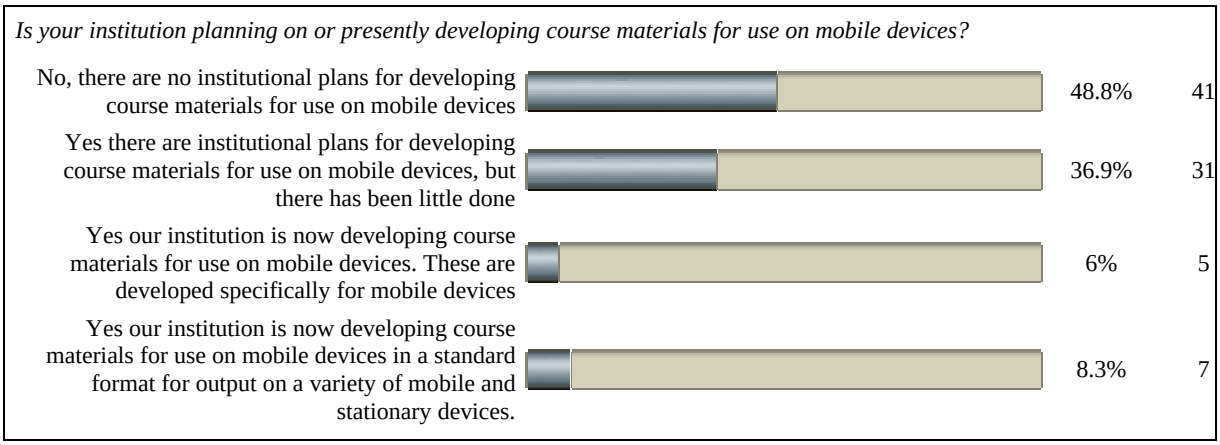


Number of responses: 87

Figure 3: Frequency distribution of responses amongst institution types

The institutions that were referred to as 'other' included a community college, an e-learning service provider, a telecom vendor and a research centre.

Figure 4 represents findings on whether the respondents' institutions have plans for developing course materials for use on mobile devices. Approximately 50% of the participating institutions do not have such plans, while 37% of institutions have envisaged developing course materials but have not as yet done so. Fourteen percent of respondents reported that their institutions indeed have developed such materials for use on mobile devices. Of these more than half reported that they had developed such materials for use on mobile devices in a standard format for output on a variety of mobile and stationary devices.



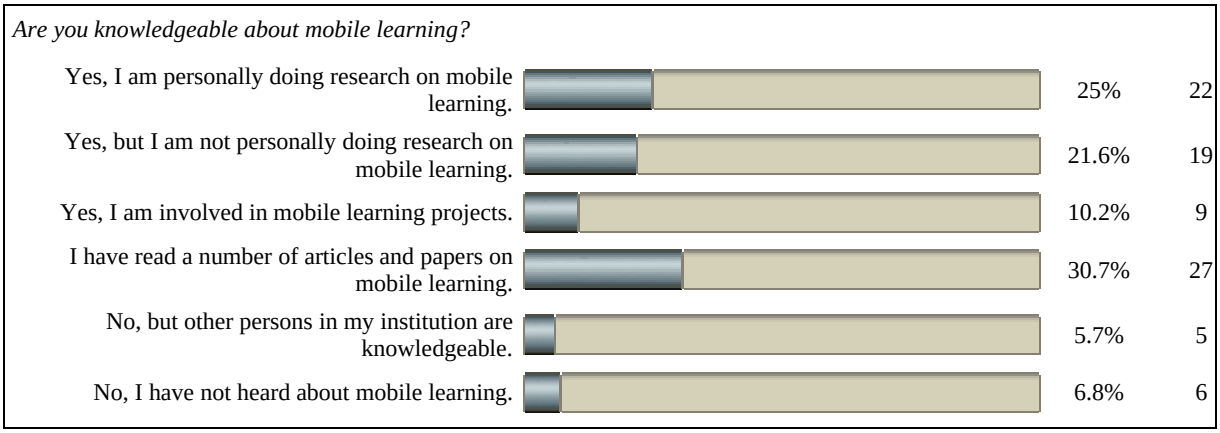
Number of responses: 84

Figure 4: Frequency distribution of responses concerning the development of mobile learning course materials

Of the nine traditional distance teaching institutions being represented in the survey 55% reported having institutional plans for, or are presently developing course materials for use on mobile devices. Respective percentages for the other institutions were 33%, 48% and 75% for the 3 purely online teaching institutions or virtual universities, 52 mixed-mode, and 8 traditional face-to-face or contact-based teaching institutions.

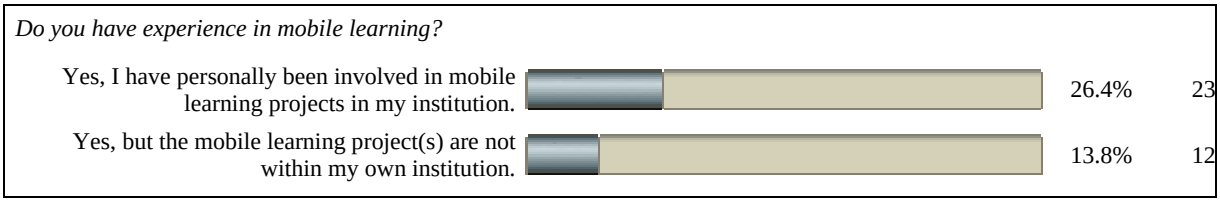
3.2 Mobile learning experience

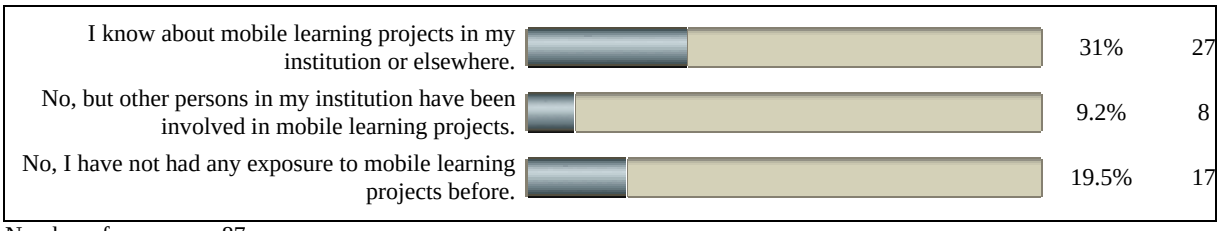
Respondents were requested to report on the extent to which they are knowledgeable about and have experience in mobile learning. These findings are represented in Figures 5 and 6. Approximately 62% of respondents reported being personally involved or have read publications on the subject, while approximately 71% reported being either actively involved, or being informed on mobile learning projects in their own or other institutions.



Number of responses: 88

Figure 5: Frequency distribution of responses with respect to being knowledgeable about mobile learning



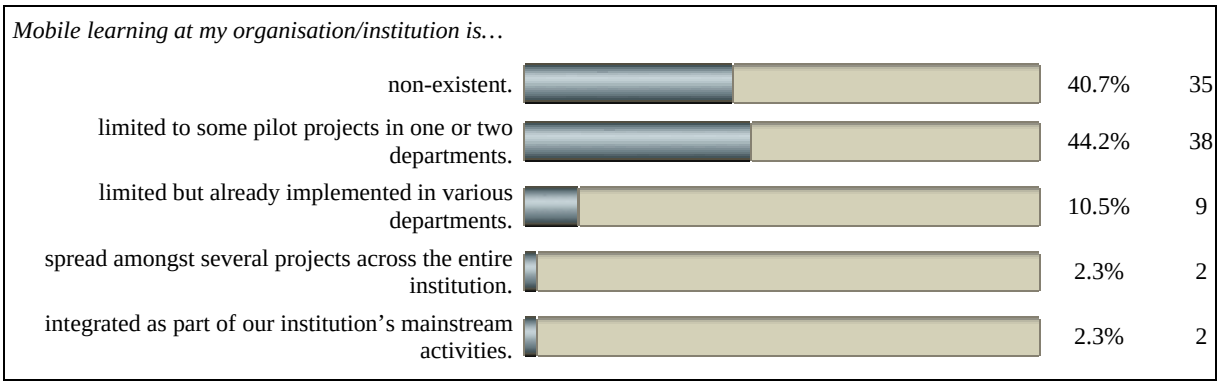


Number of responses: 87

Figure 6: Frequency distribution of responses with respect to having experience in mobile learning

3.3 Development and growth of mobile learning

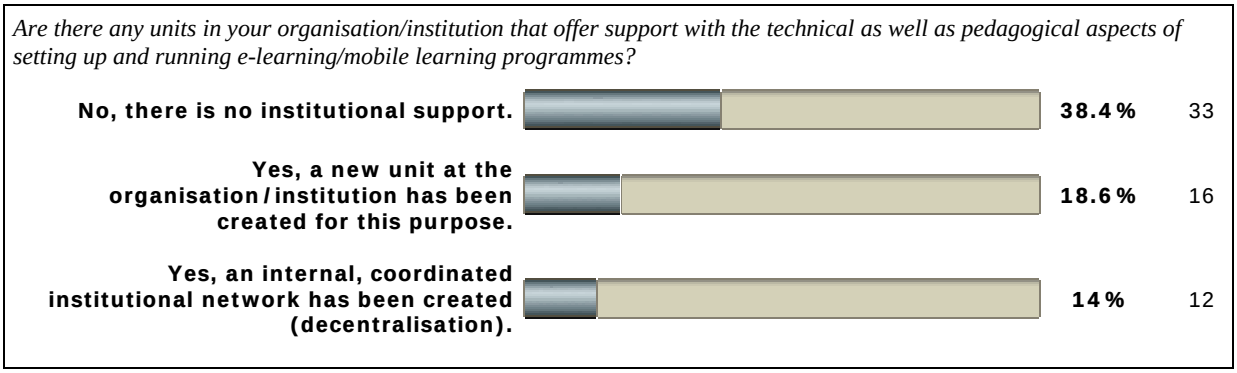
Of the 86 respondents who reported on the implementation of mobile learning within their institution, 41% reported that it does not exist, while only about 5% reported mobile learning to be either spread amongst several projects across the entire institution (2.3%) or integrated as part of their institution's mainstream activities (2.3%). The remainder had instituted mobile learning as pilot projects in one or two departments (44.2%) or had already implemented mobile learning in various departments to a limited extent (10.5%).

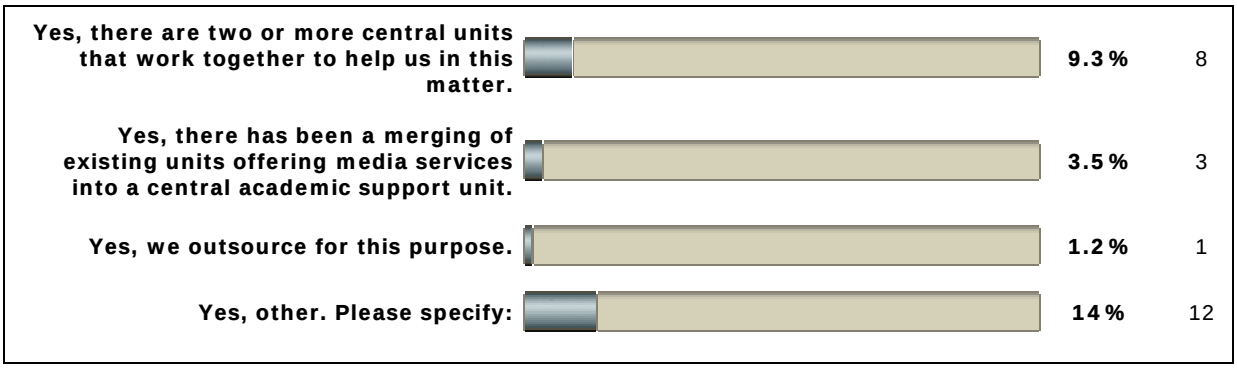


Number of responses: 86

Figure 7: Frequency distribution of responses with respect to the implementation of mobile learning within the organisation/institution

As was to be expected, non-existence or existence in some or other form of mobile learning and being knowledgeable about mobile learning were significantly associated, as was the case for non-existence or existence and having experience in mobile learning (respective Chi-square, p-values: 22.7, $p<0.0001$ and 32.9, $p<0.0001$). A significant association was, however, observed between non-existence or existence in some or other form of mobile learning at an institution and the absence or presence of some or other form of institutional support (Chi-square 9.9, $p=0.002$). This may imply that institutional support is essential for the implementation of mobile learning. Figure 8 depicts a variety of possibilities within an organisation/institution that offer support with the technical as well as pedagogical aspects of setting up and running e-learning/mobile learning programmes.

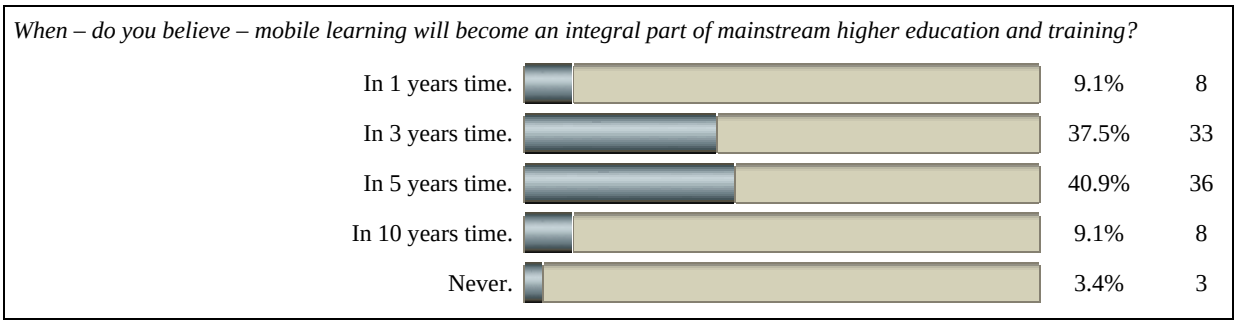




Number of responses: 85

Figure 8: Frequency distribution of responses with respect to technical as well as pedagogical support within an organisation/institution

Surprisingly, 36.4% of respondents stated that there is no support available from the teaching institution to offer e-learning or mobile learning courses, although some respondents mentioned that there are plans to set up a support unit in the near future. Mobile learning was, however, expected by the majority of respondents (78.4%) to become an integral part of mainstream higher education and training within three to five years (Figure 9).



Number of responses: 88

Figure 9: Frequency distribution of responses with respect to expected duration of time during which mobile learning will become an integral part of mainstream higher education and training

The findings depicted in Figure 10 suggest that online and distance teaching institutions are spearheading the development of mobile learning. Sixty seven percent of online teaching and 56 % of distance teaching institutions plan on, or are presently developing learning material for mobile devices, in contrast to only 24 % of traditional contact-based teaching institutions.

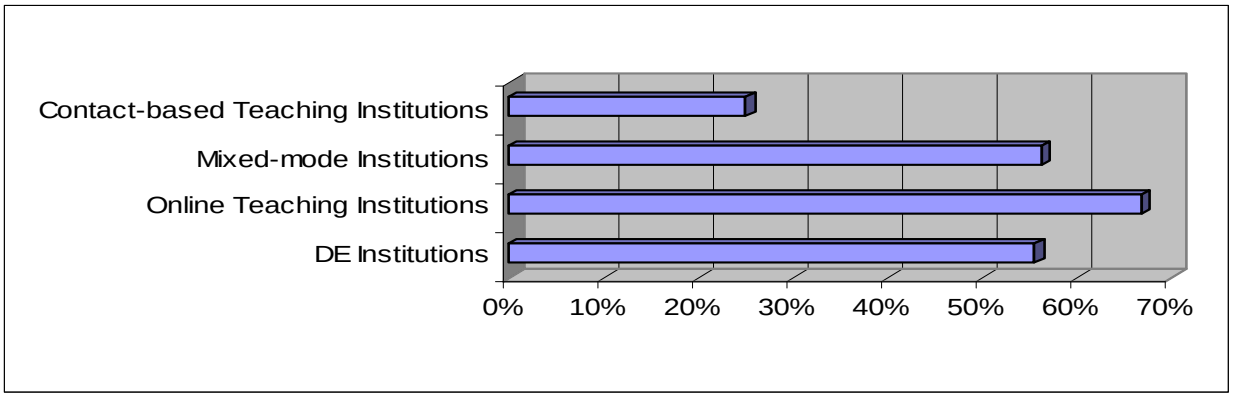
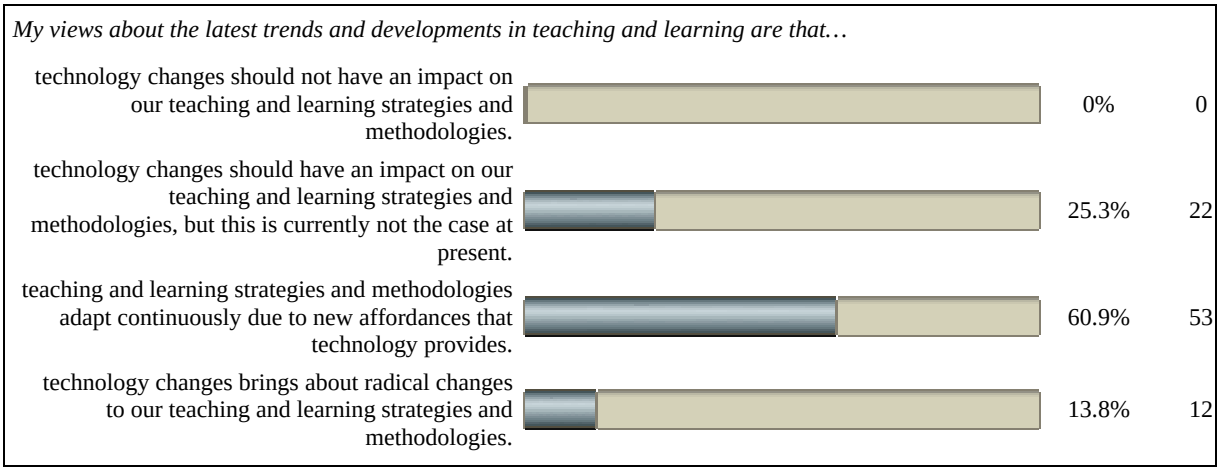


Figure 10: Institutions that plan on, or are presently developing learning material for mobile devices

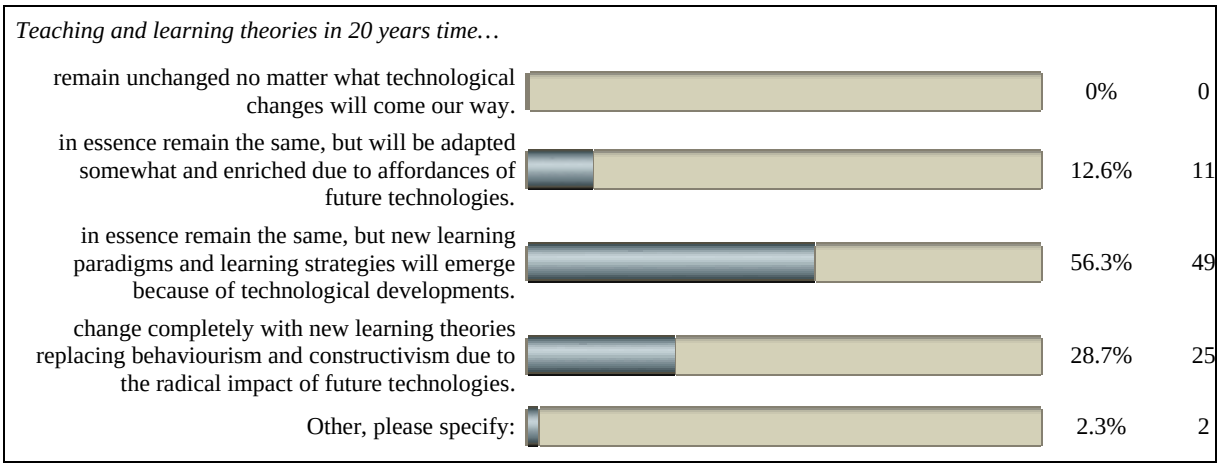
3.4 Impact of mobile technologies on teaching and learning

Figures 11 and 12 depict reflections and expectations concerning changes in teaching and learning practice as well as learning theories. Figure 13 reports on expectations concerning new strategies and methodologies being facilitated by mobile learning. The main findings are that 61% of respondents expected that teaching and learning strategies and methodologies would adapt continuously due to new affordances that technology provides (Figure 11) and 56% expected learning theories to remain the same in essence, but that new learning paradigms and learning strategies would emerge because of technological developments (Figure 12). The majority of respondents (77%) thought that mobile learning would be very helpful in enhancing teaching and learning independent of time and space (Figure 13).



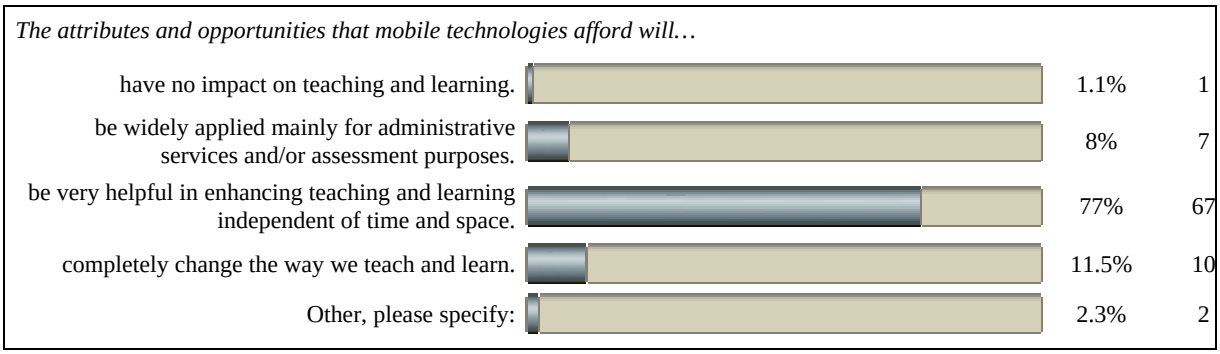
Number of responses: 87

Figure 11: Frequency distribution of responses with respect to views on trends in teaching and learning



Number of responses: 87

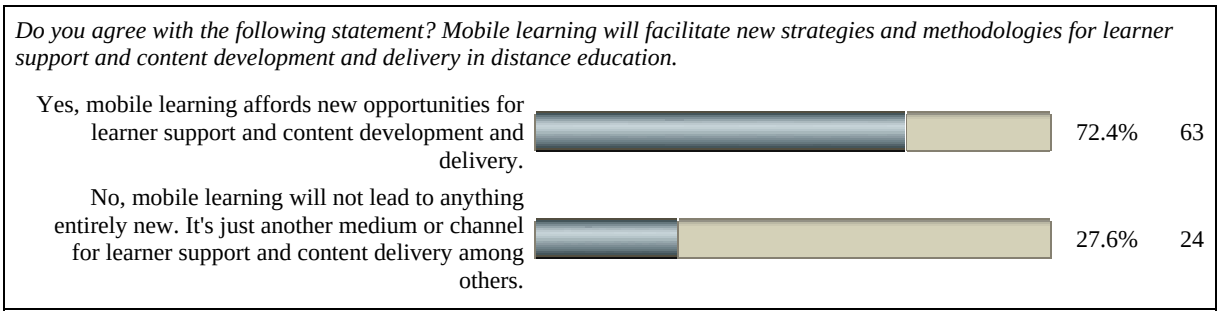
Figure 12: Frequency distribution of responses with respect to anticipated learning theories in 20 years time



Number of responses: 87

Figure 13: Frequency distribution of responses with respect to the expected impact of the attributes and opportunities that mobile technologies afford

One respondent remarked that "mobile devices will make learning even more flexible and spontaneous than 'traditional' e-learning". Most respondents (72%) believed in principle that mobile learning would afford new opportunities for learner support and content development and delivery (Figure 14).



Number of responses: 87

Figure 14: Frequency distribution of responses with respect to new strategies and methodologies being facilitated by mobile learning

Strategies and methodologies that may be afforded by mobile technology were proposed by respondents. These suggestions are grouped and categorized in the following table.

Table 2: Strategies and methodologies as proposed by respondents

Category	**#***	**Typical examples**
Learning activities	19	(Inter)active learning, authentic learning, explorative learning, project orientated learning, situated and informal learning, Qs and As.
Assessment	3	Security for testing and evaluation procedures, assessment to determine students' knowledge a day or two before a lecture/discussion to determine which topics need more attention.
Resources	9	Generation of information, sharing resources, data sourcing, access to information, navigation, m-library.
Interaction	6	More support for collaboration, more support for bottom-up content creation, enhanced social support, consulting peers and experts. Distance Educators will teach again instead of providing teaching material only.
Personalisation and individualisation	12	New strategies might emerge from better knowledge of learner behaviours and study patterns with technology, which were never examined that closely before, just-in-time learning, addressing learner styles or needs, keeping it simple, focus on small 'chunks' of learning, just-in-time support/job aids.

* Number of times suggested by respondents

The relation between anticipated affordances of mobile learning and being knowledgeable about and have experience in mobile learning was evaluated. A positive response on whether mobile learning will facilitate new strategies and methodologies for learner support and content development and

delivery in distance education was reported by 88% of individuals (15/17) who said that they were knowledgeable on mobile learning as they were personally doing research on mobile learning, 61% of individuals (11/18) who reported "Yes, but I am not personally doing research on mobile learning", 100% of individuals (7/7) who reported "Yes, I am involved in mobile learning projects", 57% who had read a number of articles and papers on mobile learning (13/23), 67% who reported "No, but other persons in my institution are knowledgeable" (2/3), and 75% who reported "No, I have not heard about mobile learning" (3/4). Concerning experience in mobile learning and a positive response on whether mobile learning will facilitate new strategies and methodologies for learner support and content development and delivery in distance education, the following percentages were observed for the items tabled:

Table 3: Experience in mobile learning and anticipated affordances of mobile learning

Experience in mobile learning…	Positive response	(n)
Yes, I have personally been involved in mobile learning projects in my institution.	88 %	15/17
Yes, but the mobile learning project(s) are not within my own institution.	67 %	6/9
I know about mobile learning projects in my institution or elsewhere.	54 %	14/26
No, but other persons in my institution have been involved in mobile learning projects.	100 %	6/6
No, I have not had any exposure to mobile learning projects before.	69 %	9/13

From these findings it is thus concluded that the expectations concerning the affordances of mobile learning are based on knowledge and experience of mobile learning.

3.5 Mobile learning applications and mobile learning activities

Respondents were requested to rate the importance of learning 'tools' for students on mobile phones or smartphones (Table 4), the importance of learning activities which are appropriate for mobile devices (Table 5) (with suggestions for additional learning activities), and the importance of applications (software) on mobile devices (Table 6). Respondents were also asked to rate the usefulness of mobile learning 'tools' for students on PDAs or smartphones (Table 7).

Table 4: Rating of importance of learning 'tools' for students on mobile phones or smartphones

	Importance ratings				
	1	**2**	**3**	**4**	**5**
Text messaging (SMS) for communication and interaction. (Number of responses: 86)	27.9% 24	18.6% 16	25.6% 22	18.6% 16	9.3% 8
Voice calls for communication and interaction. (Number of responses: 87)	12.6% 11	27.6% 24	29.9% 26	16.1% 14	13.8% 12
Text messaging to e-mail and vice versa. (Number of responses: 86)	18.6% 16	27.9% 24	19.8% 17	20.9% 18	12.8% 11
Sharing texts, notes and documents. (Number of responses: 86)	14% 12	17.4% 15	20.9% 18	22.1% 19	25.6% 22
Being connected anywhere, anytime. (Number of responses: 86)	55.8% 48	12.8% 11	4.7% 4	8.1% 7	18.6% 16
Totals for rating columns	25.8% 111	20.9% 90	20.2% 87	17.2% 74	16% 69

Rating from 1-5 where 1 is the most important
Total number of ratings: 431

Table 5: Rating of importance of learning activities which are appropriate for mobile devices

	Importance ratings				
	1	**2**	**3**	**4**	**5**
Coursework (accessing and reading learning materials) (Number of responses: 85)	10.6% 9	10.6% 9	22.4% 19	29.4% 25	27.1% 23

Assessment (quizzes, tests, questions-and-answers, etc) (Number of responses: 85)	17.6% 15	16.5% 14	23.5% 20	18.8% 16	23.5% 20
Collaborative learning (interaction with tutor, discussion with other students, group work) (Number of responses: 85)	31.8% 27	22.4% 19	25.9% 22	10.6% 9	9.4% 8
Field work (location-based learning: gathering and sharing on the site information) (Number of responses: 84)	39.3% 33	19% 16	14.3% 12	14.3% 12	13.1% 11
Information retrieval (search in databases and encyclopaedias) (Number of responses: 85)	23.5% 20	21.2% 18	24.7% 21	20% 17	10.6% 9
Totals for rating columns	24.5% 104	17.9% 76	22.2% 94	18.6% 79	16.7% 71

Rating from 1-5 where 1 is the most important
Total number of ratings: 424

The following additional learning activities and applications to be employed in mobile learning might include as suggested by respondents: authentic explorative learning, reflective diaries, Pre-programmed simulations and scenarios for onsite (field) applications, sharing pictures and video, podcasting, tracing and tracking students locations, data collection in applied settings for personal or group projects, daily new vocabulary, exam reminders, mobile gaming and quizzes, location based services (e.g. Semapedia.org) and quick reference systems.

Table 6: Rating of importance of applications (software) on mobile devices

	Importance ratings				
	1	**2**	**3**	**4**	**5**
Mobile Office (Word, Excel, Powerpoint, etc). (Number of responses: 85)	16.5% 14	31.8% 27	20% 17	10.6% 9	21.2% 18
Diary and scheduling. (Number of responses: 77)	28.6% 22	20.8% 16	20.8% 16	22.1% 17	7.8% 6
Audio and video applications. (Number of responses: 84)	22.6% 19	20.2% 17	21.4% 18	19% 16	16.7% 14
Imaging. (Number of responses: 75)	4% 3	29.3% 22	17.3% 13	32% 24	17.3% 13
Additional accessories (notes, calculator, etc.). (Number of responses: 78)	14.1% 11	16.7% 13	26.9% 21	17.9% 14	24.4% 19
Browser for internet connection/online data services. (Number of responses: 85)	37.6% 32	23.5% 20	10.6% 9	16.5% 14	11.8% 10
Totals for rating columns	20.9% 101	23.8% 115	19.4% 94	19.4% 94	16.5% 80

Rating from 1-5 where 1 is the most important
Total number of ratings: 484

Table 7: Rating of usefulness of the mobile learning 'tool' that were perceived as being most useful

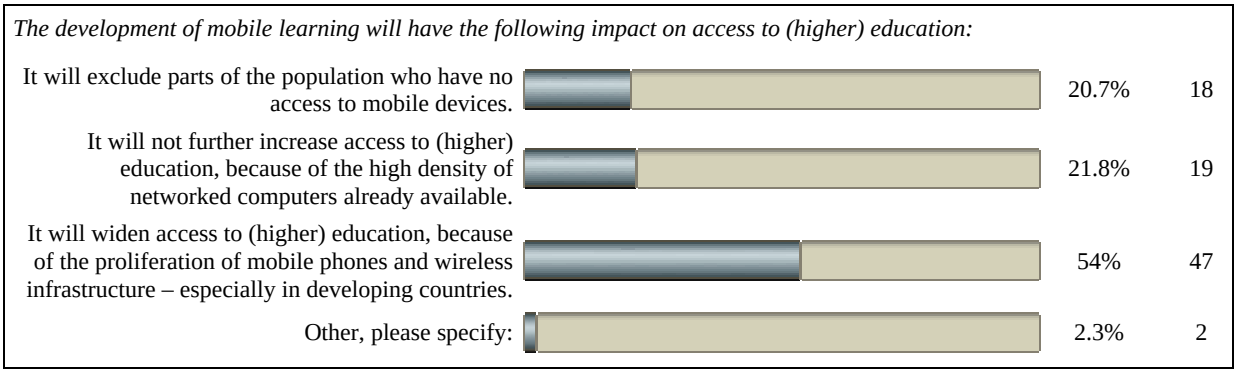
	Importance ratings				
	1	**2**	**3**	**4**	**5**
Sharing texts, notes and documents via bluetooth or wireless connections. (Number of responses: 82)	15.9% 13	25.6% 21	22% 18	22% 18	14.6% 12
Accessing class notes, schedules, documents, websites, etc via wireless connections. (Number of responses: 82)	23.2% 19	26.8% 22	25.6% 21	14.6% 12	9.8% 8
Using the scheduling and diary applications for organising their learning environments. (Number of responses: 81)	14.8% 12	29.6% 24	19.8% 16	16% 13	19.8% 16
Using mobile Office or the like applications for their normal learning activities. (Number of responses: 82)	11% 9	19.5% 16	22% 18	25.6% 21	22% 18

Being connected anywhere, anytime. (Number of responses: 82)	52.4% 43	9.8% 8	9.8% 8	7.3% 6	20.7% 17
Totals for rating columns	23.5% 96	22.2% 91	19.8% 81	17.1% 70	17.4% 71

Rating from 1-5 where 1 is the most important
Total number of ratings: 409

3.6 Mobile learning and access to (higher) education

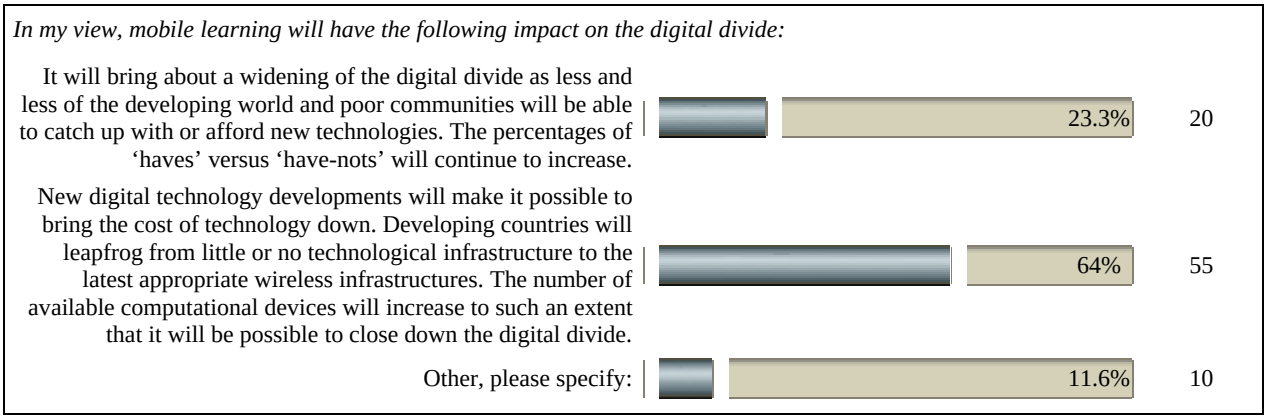
Reponses were elicited on expectations concerning the impact of mobile learning on access to (higher) education. The findings are depicted in Figure 15. The general expectation (54%) was that it would widen access to (higher) education, because of the proliferation of mobile phones and wireless infrastructure – especially in developing countries.



Number of responses: 86

Figure 15: Frequency distribution of responses with respect to expected impact on access to (higher) education

Figure 16 provides information on the anticipated effect of mobile learning on the digital divide. Sixty four percent of respondents suggested that the new digital technology developments will have positive effects concerning access to and costs of wireless technology. Several respondents emphasized that both statements are true to a certain degree: "I believe they complement one another and proceed to stabilize degrees of inequality we are already confronted with. If noticeable (mass), positive changes are to be noticed the time frame in my opinion would be 20 years". Another respondent reminded us that "The cost of technology will go down and access will increase, still, but there will remain parts of the population without access. However, those who previously 'had not' may now 'have', but maybe their technologies will be a little bit older". Only one of 86 respondents did not agree within any of the two statements and stated in a comment that mobile learning would not affect the digital divide at all.

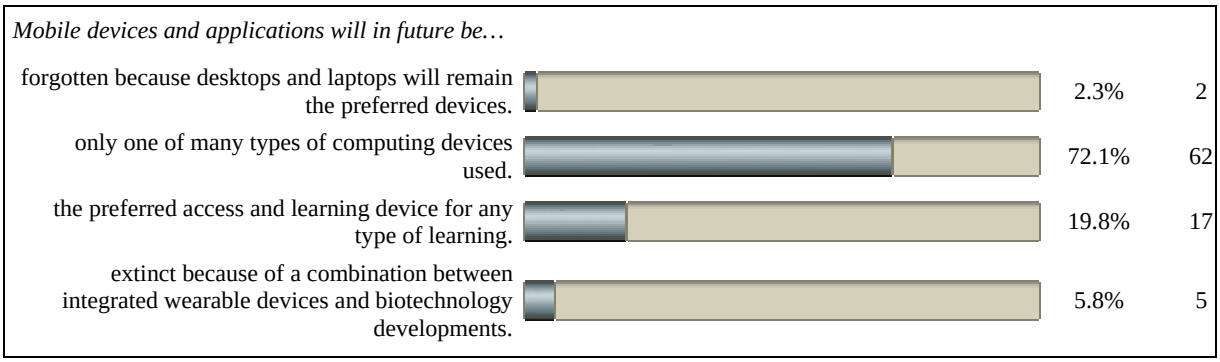


Number of responses: 85

Figure 16: Frequency distribution of responses with respect to the effect of mobile learning on the digital divide

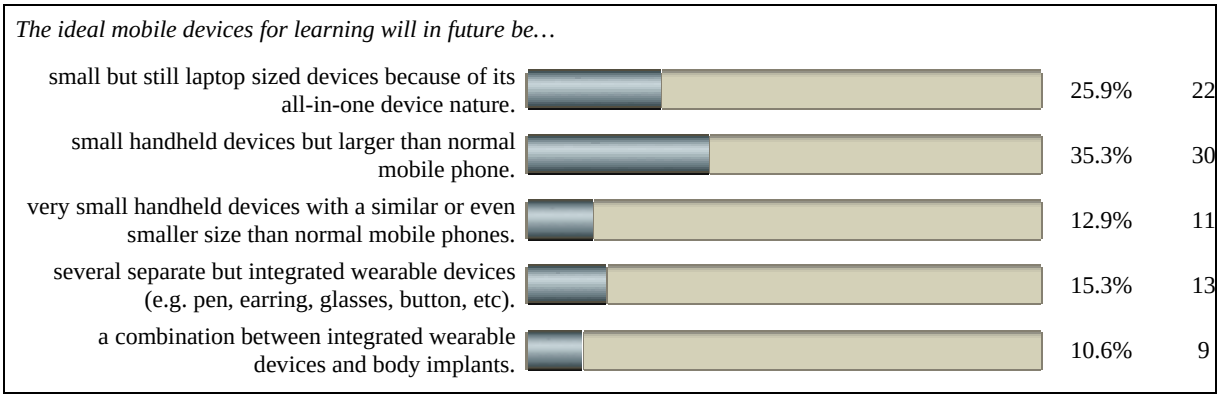
3.7 Future development of mobile learning

Mobile devices and applications are expected to be only one of many types of computing devices used in future, as is evident from 72% of responses depicted in Figure 17 on the significance of mobile devices in the future. Responses concerning the attributes of the ideal mobile devices for learning are depicted in Figure 18.



Number of responses: 86

Figure 17: Frequency distribution of responses with respect to the significance of mobile devices in the future



Number of responses: 85

Figure 18: Frequency distribution of responses with respect to the attributes of mobile devices in future

The following table summarizes agreements on statements concerning the major weaknesses of mobile devices that might hinder the distribution of mobile learning.

Table 8: Rating on statements concerning major weaknesses of mobile devices that might hinder the distribution of mobile learning

Major weaknesses of mobile devices that might hinder the distribution of mobile learning: Do you agree with the following statements (1 = strongly disagree; 5 = strongly agree)

	1	**2**	**3**	**4**	**5**
1. Displays and screens are too small to present complex learning material. (Number of responses: 85)	11.8% 10	5.9% 5	20% 17	28.2% 24	34.1% 29
2. Screen size should not be important as mobile devices should be used for communication and interaction purposes rather than for content distribution. (Number of responses: 84)	14.3% 12	21.4% 18	16.7% 14	32.1% 27	15.5% 13
3. Costs of mobile network services will continue to decrease and should not play an important role. (Number of responses: 85)	4.7% 4	18.8% 16	21.2% 18	36.5% 31	18.8% 16
4. Technological advancements make it possible to have sufficient memory for small images, audio	3.5% 3	4.7% 4	14.1% 12	42.4% 36	35.3% 30

and video clips. (Number of responses: 85)					
5. Device capabilities and mobile network infrastructures are improving to provide sufficient data transmission capacity (e.g. 3G and HSDPA). (Number of responses: 83)	3.6% 3	9.6% 8	15.7% 13	41% 34	30.1% 25
6. Limited battery life of mobile devices is a problem for extensive use. (Number of responses: 85)	8.2% 7	21.2% 18	11.8% 10	29.4% 25	29.4% 25
Totals for rating columns	7.7% 39	13.6% 69	16.6% 84	34.9% 177	27.2% 138

Rating:1 = strongly disagree; 5 = strongly agree
Total number of ratings: 507

4 Conclusions and further perspectives

The aim of this paper was to explore mobile learning as a new field of pedagogical activity, with a view to determining if mobile learning is a new generation of distance education or perhaps even an educational paradigm shift.

a) Integration into the mainstream?

Currently the penetration of mobile learning is low, with only 14% of institutions represented in this study reporting that their institutions indeed have developed course materials for use on mobile devices. The majority of respondents (72.7 %) are from traditional distance teaching institutions, purely online teaching institutions/virtual universities or mixed-mode institutions offering both distance education and face-to-face classes, since the questionnaire was addressed to distance educators via distance education networks. This may have induced a bias in the findings; nonetheless it may be inferred that the application of mobile learning is even much lower in traditional, campus-based higher education and training institutions.

Notwithstanding the low penetration, 55 % of distance teaching institutions and 48% of mixed-mode teaching institutions plan on, or are presently developing learning material for mobile devices. A high percentage of respondents (88%) reported being already personally involved in mobile learning projects or to have read publications on the subject (Figure 5), while approximately 71% reported either being actively involved or being informed on mobile learning projects in their own or other institutions (Figure 6). Furthermore, approximately 78 % of respondents believed that mobile learning will become an integral part of mainstream higher education and training within 3-5 years (Figure 9). Sixty four percent of respondents suggested that wireless technology developments will have positive effects on closing down the digital divide.

Therefore, it cannot be claimed that mobile learning is part of mainstream education and training yet, but it has potential and there is a demand to move from pilot project status to the mainstream. Organizational student and faculty support is of the utmost importance in order to foster the education innovation process (cf. section 3.3).

b) A new generation of distance education?

Properly designed mobile learning can be spontaneous, ubiquitous and pervasive. It affords various opportunities for teaching and learning, especially interaction (two-way communication), flexibility, and maximal access, even in contrast to 'traditional' e-learning. Fifty four percent of respondents suggested that mobile learning will widen access to (higher) education, because of the proliferation of mobile phones and wireless infrastructure - especially in developing countries.

The role that communication and interaction play in the learning process is critical in contemporary learning paradigms. Mobile technologies seem to provide opportunities for optimizing interaction and communication between lecturers and learners, among learners and among members of communities of practice. Mobile learning enhances collaborative, co-operative and active learning.

Based on the criteria of interaction, independence, access and flexibility we can conclude that mobile learning has the potential to become a new generation of distance education in the sense of Garrison (1985) - provided that mobile learning becomes integrated into the mainstream provision of education and training.

c) An educational paradigm shift?

The expectations expressed by the respondents concerning the impact of mobile learning on teaching and learning strategies and methodologies, as well as on learning theories (Figures 11 and 12), may signify a change in thinking, in that technology is expected to induce changes in the former, while learning theories are expected to remain the same in essence. Only 29% of respondents expect learning theories to change completely, with new learning theories replacing behaviourism and constructivism due to the radical impact of future technologies (Figure 12). The majority of respondents (72 %) agreed that mobile learning affords new opportunities for learner support, content development and delivery. However, only 12 % of polled distance education experts believed that mobile technologies will "completely change the way we teach and learn", while the majority of respondents (77%) thought that mobile learning would be very helpful in enhancing teaching and learning independent of time and space. An array of new strategies and methodologies were proposed by respondents.

Mobile learning affords new channels of support, among others: "The emphasis should be on 'enhancing' learning opportunities, rather than 'replacing' other forms of teaching and learning".

In terms of the definition of educational paradigm shifts by Peters (2004) and the data collected, we cannot confirm that we face an educational paradigm shift with the emergence of mobile learning. Learning with mobile devices appears to be a further development of 'traditional' e-learning.

d) Future development of mobile learning

The final frontier to cross to convince us that mobile learning is the new and next generation of distance education, is for mobile learning to be incorporated into mainstream education.

Beside the technical and economic challenges that were mentioned, it is the support of the faculty, teachers and trainers that is critical for the success of education innovation (Zawacki-Richter, 2005). With regard to higher education, Bates (2000) emphasizes that "presidents may dream visions, and vice presidents may design plans, and deans and department heads may try to implement them, but without the support of faculty members nothing will change" (p. 95). Acceptance of new media, not only by pioneers and early adoptors, but also by the majority of users (cf. Rogers, 1995) is the prerequisite for education innovation.

Keegan (2005) claims that mobile learning is not perceived to be a satisfactory revenue stream by the telecommunications operators, which is the major barrier to moving mobile learning from single project status to the mainstream. He proposes five solutions to this problem:

> "Firstly, there are thousands of universities and further and higher education colleges all over the world. If they can all be convinced to accept mobile learning as their normal means of communication with all their students on changes of timetable, submission deadlines, enrolment procedures and other administrative necessities, a massive mobile learning revenue stream will already be set up.
>
> Secondly, the production of a mobile learning development kit for distribution to universities and colleges to enable them to introduce mobile learning will set up another revenue stream.
>
> Thirdly, the production of course guides, course summaries, examination reminders, helps with difficult parts of a course, will set up another revenue stream.
>
> Fourthly, the production of full course modules for PDAs, handhelds, palmtops, and also for smartphones and eventually for mobile phones, will set up another revenue stream.
>
> Finally, the literature of the field needs to be developed, books on mobile learning need to be written, conferences like this one need to be organised" (p. 16).

It was shown in this study that mobile technologies afford new opportunities for teaching and learning which might convince innovative faculty, teachers and trainers to consider adopting mobile learning.

Perhaps the hard work for acceptance done in the history of distance education and e-learning will also have a positive impact on the development of mobile learning. It now has to prove the value it can add to the teaching and learning process on a large scale.

Only when such evidence is exhibited, can we share the optimistic estimation of Wagner (2005): "Whether we like it or not, whether we are ready for it or not, mobile learning represents the next step in a long tradition of technology mediated learning. It will feature new strategies, practices, tools, applications, and resources to realize the promise of ubiquitous, pervasive, personal, and connected learning. It responds to the on-demand learning interests of connected citizens in an information-centric world" (p. 44).

5 References

Battenberg, R. W. (1971). The Boston Gazette, March 20, 1728. *Epistolodidaktika, 1*, 44-45.

Brindley, J. E., & Paul, R. (1996). Lessons from distance education for the university of the future. In R. Mills & T. A. (Eds.), *Supporting the learner in open and distance learning* (pp. 43-55). London: Pitman Publishing.

Brown, J.S. (1999). *Learning, Working and Playing in the Digital Age*. Paper delivered at the 1999 Conference on Higher Education of the American Association for Higher Education, March 1999, Washington, USA.

Brown, T. H. (Ed.). (1999). *A new education model for the university that promotes flexible learning*. Pretoria: University of Pretoria.

Brown, T. H. (2004). The role of m-learning in the future of e-learning in Africa. In D. Murphy, R. Carr, J. Taylor & W. Tat-meng (Eds.), *Distance education and technology: Issues and practice* (pp. 197-216). Hong Kong: Open University of Hong Kong Press.

Brown, T. H. (2005). Towards a model for m-learning in Africa. *International Journal on E-learning, 4*(3), 299-315.

Brown, T. H. (2006). M-learning in Africa: Doing the unthinkable and reaching the unreachable. *Open and Distance Learning Praxis in Africa*. Pretoria: UNISA Press.

Collis, B. & Moonen, J. (2001). *Flexible learning in a digital world*. London: Kogan Page.

Daniel, J. (1996). *Mega-universities and knowledge media - technology strategies for higher education*. London: Kogan Page.

Daniel, J. (1998). Can you get my hard nose in focus? Universities, mass education and appropriate technology. In M. Eisenstadt & T. Vincent (Eds.), *The knowledge web - learning and collaborating on the net* (pp. 21-29). London: Kogan Page.

Delling, R. M. (1992). *Zur Geschichte des Fernstudiums - Eine Ausstellung des Deutschen Instituts für Fernstudien an der Universität Tübingen vom 15. Juni bis 11. Juli 1992*. Tübingen: DIFF.

Garrison, G. R. (1985). Three generations of technological innovation in distance education. *Distance Education, 6*(2), 235-241.

Gladieux, L. E., & Swail, W. S. (1999). *The virtual university and educational opportunity - issues of equity and access for the next generation*. Washington, D.C.: The College Board.

Gourley, B. (2004). *Thee digital divide as a development issue.* Paper presented at the Conference of the International Council for Open Learning and Distance Education (ICDE), Hong Kong, China.

Hiltz, S. R. (1995). *Teaching in a virtual classroom [tm].* Paper presented at the International Conference on Computer Assisted Instruction ICCAI'95, Hsinchu, Taiwan.

Hülsmann, T. (2000). *The costs of open learning: A handbook.* Oldenburg: Bibliotheks- und Informationssystem der Universität Oldenburg.

ITU (2004). *Africa – The world's fastest growing mobile market: Does mobile technology hold the key to widening access to ICTs in Africa?* Article in M2 Presswire, 26 April, 2004.

Keegan, D. (1986). *Foundations of distance education*. Beckenham: Croon Helm.

Keegan, D. (2003). The future of learning: From elearning to mlearning. Retrieved September 13, 2006, from http://learning.ericsson.net/mlearning2/project_one/book.html

Keegan, D. (2005). *The incorporation of mobile learning into mainstream education and training.* Paper presented at the World Conference on Mobile Learning, Cape Town.

Kukulska-Hulme, A., & Traxler, J. (Eds.). (2005). *Mobile learning - a handbook for educators and trainers*. London: Routledge

Kukulska-Hulme, A., & Traxler, J. (2005b). Mobile teaching and learning. In A. Kukulska-Hulme & J. Traxler (Eds.), *Mobile learning - a handbook for educators and trainers* (pp. 25-44). London: Routledge..

Lea, M. R., & Nicoll, K. (Eds.). (2002). *Distributed learning - social and cultural approaches to practice*. London: Routledge/Falmer, Open University.

Mason, R. (1989). An evaluation of cosy on an open university course. In R. Mason & A. Kaye (Eds.), *Mindweave: Communication, computers and distance education* (pp. 115-145). Oxford: Pergamon Press.
Mills, R., & Tait, A. (Eds.). (1999). *The convergence of distance and conventional education: Patterns of flexibility for the individual learner*. London: Routledge.
Nipper, S. (1989). Third generation distance learning and computer conferencing. In R. Mason & A. Kaye (Eds.), *Mindweave: Communication, computers and distance education* (pp. 63-73). Oxford: Pergamon Press.
Peters, O. (2004). The educational paradigm shifts. In O. Peters (Ed.), *Distance education in transition - new trends and challenges* (4th ed., pp. 25-35). Oldenburg: BIS.
Peters, O. (2001). *Learning and teaching in distance education*. London: Kogan Page.
Quin, C. (2001). mLearning: Mobile, Wireless, In-Your-Pocket Learning. *LiNE Zine*, Fall 2002. Available at: http://www.linezine.com/2.1/features/cqmmwiyp.htm
Rogers, E. (1995). *Diffusion of innovations*. New York: Free Press.
Rosenberg, M. J. (2001). *E-learning: Strategies for delivering knowledge in the digital age*. New York: McGraw-Hill.
Ryan, Y. (2001). The provision of learner support services online. In G. Farrel (Ed.), *The changing faces of virtual education* (pp. 71-94). Vancouver, Canada: The Commonwealth of Learning.
Salmon, G. (2000). *E-moderating - the key to teaching and learning online*. London: Kogan Page.
Sauter, A. M., & Sauter, W. (2002). *Blended learning - Effiziente Integration von E-Learning und Präsenztraining*. Neuwied, Kriftel: Luchterhand.
Schreiber, D. A. (1998). Instructional design of distance training. In D. A. Schreiber & Z. L. Berge (Eds.), *Distance training - how innovative organizations are using technology to maximize learning and meet business objectives* (pp. 37-65). San Francisco: Jossey-Bass.
Schulmeister, R. (1999). Virtuelle Universitäten aus didaktischer Sicht. *Das Hochschulwesen - Forum für Hochschulforschung, -praxis und -politik*(6), 166-174.
Shapshak, D. (2002). Unwiring Africa - Digafrica 2001. Retrieved September 12, 2006, from http://groups.yahoo.com/group/DigAfrica.
Soloway, E. (2003). *Handheld computing: Right time, right place, right idea.* Paper delivered at the IEEE international conference on advanced learning technologies (ICALT). July 2003, Athens, Greece.
Srivastava, M., & Reddy, V. V. (2002). Is information and communication technology reshaping the learner support? *University News, 40*(4), 43-54.
Tait, A. (1995). Student support in open and distance learning. In F. Lockwood (Ed.), *Open and distance learning today* (pp. 232-241). London: Routledge.
Tait, A. (2000). Planning student support for open and distance learning. *Open Learning, 15*(3), 287-299.
Taylor, J. C. (1995). Distance education technologies: The forth generation. *Australian Journal of Educational Technology, 11*(2), 1-7.
Taylor, J. C. (2001). *Fifth generation distance education* (No. 40). Canberra, Australia: Department of Education, Training and Youth Affairs - Higher Education Division.
Thorpe, M. (2001). Learner support: A new model for online teaching and learning. In UKOU (Ed.), *Student services at the UK Open University, papers presented to the 20th World Conference of the ICDE, Düsseldorf, Germany, April 1-5, 2001* (pp. 13-22).
Thorpe, M. (2002). Rethinking learner support: The challenge of collaborative online learning. *Open Learning, 17*(2), 106-119.
Turoff, M. (1995). *Designing a virtual classroom [tm]*. Paper presented at the International Conference on Computer Assisted Instruction ICCAI '95, Hsinchu, Taiwan.
Urdan T. A., & Weggen, C. C. (2000). Corporate e-learning: Exploring a new frontier. Retrieved September 7, 2001, from http://www.wrhambrecht.com/research/coverage/elearning/ir/ir_explore.html
Wagner, E. D. (2005). Enabling Mobile Learning. *EDUCAUSE Review, 40*(3), 40-53.
Wessner, M. (2001). Software für E-Learning: Kooperative Umgebungen und Werkzeuge. In R. Schulmeister (Ed.), *Virtuelle Universität virtuelles Lernen* (pp. 195-219). München, Wien: Oldenbourg.
Zawacki-Richter, O. (2004). *Support im Online Studium - Die Entstehung eines neuen pädagogischen Aktivitätsfeldes*. Innsbruck: StudienVerlag.
Zawacki-Richter, O. (2005). Online Faculty Support and Education Innovation – A Case Study. *European Journal of Open and Distance Learning (EURODL)*, Volume 1. Available at http://www.eurodl.org/materials/contrib/2005/Zawacki_Richter.htm

Acknowledgements

We would like to thank sincerely Dr. Ulrich Bernath, Vice-President of the European Distance and E-Learning Network (EDEN), for his support (http://www.eden-online.org). The mobile learning questionnaire was sent to all EDEN members who gave us valuable feedback.

Furthermore we would like to express our gratitude to Dr. Gerald Lembke and Nayla Fawzi (LearnAct!, http://www.learnact-gmbh.de) who implemented the mobile learning questionnaire using Webropol (http://www.webropol.com).

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MOTEL: Designing a virtual geo-tagging framework for use in higher education

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Abstract

Higher Education students are highly mobile; they move between learning venues such as lecture halls, the field, labs, home, and excursions. In order to understand how students used technology to support them in their different learning venues, we carried out ethnographic flavored field studies where we followed biology students and faculty in their learning/research activities at the University of Bergen, Norway. We identified both a need for support in their activities and for data transfer between various learning venues. Based on these studies, we have designed MOTEL, a framework for a virtual geo-tagging. This paper discusses our views on mobile learning, describes our field studies and the resulting design decisions, and introduces the MOTEL framework.

Designing a virtual geo-tagging framework for use in higher education

> "The value may not be immediately apparent. But 10 years from now, nobody who's geotagging their photos is going to regret it" Flickr CEO Stewart Butterfield

Tools we use affect the way we conduct our lives. In particular, the development of, and innovations in digital technologies has led to profound changes in society. Säljö (2002) writes about how new technologies have changed the conditions for work, learning and communication in the 21st Century. Today, people are not only equipped with technologies that are more powerful and feature-rich than ever, but also the social transformations are perhaps even more compelling. The current digital technologies of our time influence the way we think, even the 'metaphors we use' (Lakoff & Johnson, 1980) including our complete social organization. As Bolter argues, information and communication technology is the "defining technology" of our time (Bolter, 1984, p. 11). Digital technologies are shaping how we communicate (e.g., using mobile phones, Instant Messaging, advanced groupware systems), how we retrieve and look up information (using web browsers, and SMS-services such as 'TLF 1985'), produce content (e.g., take images with digital cameras), how we utilise on-line services to share what we produce in social networks (e.g., photography communities such as bildegalleriet[1] in Norway), the way we engage in joint efforts and contribute (e.g., Wikipedia), and how we chose to express ourselves (e.g., artists using weblogs). It is important to notice, however, the influence works both ways; humans are also shaping technology through use. They appropriate the technology, customize,

and add features through co-construction enabled by new and more powerful tools (e.g., social software such as MySpace.com).

The educational sphere is by no way unaffected. An increasing number of students come to school with new digital skills and experiences. As they only spend 14% of their time in formal educational settings, the digital experience they gain as a natural part of their lives has a strong impact on their identity and how they express themselves. For example, they develop these skills by being part of: 'smartmobs' (Rheingold, 2003); through coordinated or ad-hoc collective actions enabled by pervasive technologies; by participating (even lurking) in online communities such as IRC (Internet Relay Chat) networks, gaming communities or web forums; or, by customizing their weblog or editing a movie for online publishing on a video sharing sites such as YouTube. Through these forms of participation, production and self-expression they gain new forms of digital literacy. It is not just the youth who are developing these skills, adults are also appropriating this new technology-professors are sharing their material online, podcasting lectures, writing weblogs and grandmothers are having video calls with their grandchildren. Few seem to be unaffected by the digital 'revolution'.

Mobile technologies have become part of our daily lives through personal use of advanced digital devices for learning, work, communication, recreation and entertainment. Mobile phones, digital personal assistants, portable media players[2], digital entertainment gadgets (e.g., the Tamagotchi[3]) and game consoles[4] are all devices that blend transparently into our lives and, for the youth of today, are hardly thought of as technologies anymore-—they are just a 'mobile' or a 'game station'. As youth are becoming more accustomed to using a plethora of devices, using more complex functions such as mobile blogging or posting images to online sharing

communities, one question is if it is possible to take advantage of these digital skills in education settings.

Baggetun (2006) is investigating how mobile technologies can enhance and support learning and research activities in higher education. While earlier ways of thinking about mobile learning were to deliver content to smaller devices to support 'anywhere -anyplace' mode learning (e.g., Rekkedal et al, 2005), the focus here is on developing tools and mechanisms in such a way that students can go from being consumers of ready made material to producers of content in collaboration. In order to understand how students used technology, we carried out ethnographic flavored field studies where we followed biology students and faculty in their learning/research activities at the University of Bergen, Norway. We identified both a need for support in their activities and for data transfer between various learning venues. Based on these studies, we designed and implemented MOTEL, an application and a framework for a virtual mobile geo-tagging.

The paper begins with a look at mobile learning research. Then we describe our field studies and present MOTEL. The paper concludes with a discussion about what mobile learning means in the context of our work.

Enhancing learning using mobile devices

One of the first to promote ideas of using a portable and personal computer as a tool for learning was Allen Kay (1972). Kay provided researchers of the time, a vision about a portable computing device (or "portable information manipulator" as he chose to call these devices), named the DynaBook, for use for learning. Kay did not claim that computers were necessary for children in order to learn, but that computers can provide children (and adults) with a better and more flexible tool. He also elaborated that the pedagogical merits of a personal computing device

was undeniable—an idea even more heavily supported today through the One Laptop per Child project initiative (http://laptop.org).

In recent years there has been a focus on enhancing learning by means of digital mobile devices. This field is referred to as mLearning (short for mobile learning). The research is versatile and various approaches are taken. First and foremost the research concerns how portable devices such as ultra portables, tablets, PDA's, etc. can support learning. Approaches may, however, include fixed devices such as large shared/information displays and other infrastructure that connect the mobile use to other resources. Mobile learning can be seen to be both orchestrated and serendipitous. The type and role of technology typically varies with context of use (e.g., primary schools, higher education, museums).

While there are some that believe that mLearning´s main advantage is that learning is accessible for students independent of time and place (anywhere - anytime learning learning), other projects go beyond this initial idea. This section describes some of these promising/innovative ways to use mobile technologies in learning activities.

Participatory simulations. One innovative example of utilizing mobile technologies in education is through participatory simulations where small handheld devices are used to 'play' out an augmented reality simulation in a class. Studies such as Colella (1998) have shown that such participatory simulations motivated participants to take part in the simulation and subject matter, enabled shared task solving, provided a substrate for collaboratively designing and running experiments, and led to a new language to talk about the mechanisms to be learned in the simulation play. On the other hand Wilensky & Stroup (1999) focused on employing participatory simulations as a way of fostering the understanding of dynamic systems. A field they see as a new kind of literacy. It is also interesting to see that these researchers try to utilize and

create game play in their settings in order to engage their students (e.g., Klopfer, Squire, & Jenkins, 2002).

Probeware in science education. Another area of use of mobile technology in education is the use of probes/sensors in science education. These projects are using probes attached to mobile devices in order to investigate real, often immediate (Bannasch & Tinker, 2002), natural phenomenon such as temperature, light, and acidity. Others are designing specific field trips where probes are used together with supporting infrastructure constituting complete intelligent environments (for example, see Ambient Wood, Rogers et al., 2004). The small form factor of these devices supports social interaction more easily, and the increased computing performance enables data from the probes to be processed in a way not possible before. This provides the learners with new representations, such as powerful visualizations, suitable for learning about the topic under scrutiny. These small portable devices and probes enable students and researchers to bring tools, and even complete activities that were traditionally only available in the lab, into the field.

As mini computers. Sometimes mLearning is looked upon as a pure extension of elearning where mobile devices are viewed as supporting "everywhere and anywhere learning". Research is focused on how existing learning objects, learning content, and exercises can be adapted to fit on small devices with limited resources (e.g., Rekkedal et al., 2005). Further, there are efforts to make industry standards for mobile learning. In this approach one try to overcome the fact that most mobile computing devices are inferior compared to desktop computers with regard to size of display, processing power, battery etc.

There is growing interest from commercial companies in producing both content and applications that are adapted to fit on small devices. For example, Avantgo[5] is a commercial

service delivers special formatted content to small screen devices. Another example is the porting of desktop applications to mobile devices. The Inspiration mind mapping tool is such an example (see http://www.inspiration.com/productinfo/handhelds/index.cfm).

Guides. Another active area of research and development is the use of mobile devices as digital guides for use in museums (also exploratoriums) and by tourists walking around at a site. The promise is in using mobile technology to enhance the museum experience for the visitor by extending the visit with before and after visit activities. By adding a learning dimension to the guide, it becomes a tool for both exploration and reflection. Research questions often ask about how these technologies affect the engagement of the visitors with the exhibit, and how they coordinate and navigate between the augmented virtual exhibit and the real exhibit (Spasojevic & Kindberg, 2001).

Coordinated joint efforts. There is also an area of research where researchers have been orchestrating in detail collaborative activities by the use of mobile devices. In these instances, mobile devices are usually seen to be better suited for facilitating collaborative learning by supporting the close social interaction necessary to coordinate collaborative tasks (e.g., Zurita & Nussbaum, 2004). For many of these projects detailed analysis of the interaction afforded by small devices have resulted in the design of applications and activities that take advantage of the affordances of using small mobile devices in collaborate face-to-face interactions.

Geo/location systems. An area increasingly receiving attention is the utilization of location technology as an element in mobile learning systems. Simultaneous to the radical improvements in small mobile computing devices, there has been progress and important developments in location technology that has laid the foundations for using this technology as a part of mLearning. One important event was in 2000 when GPS selective availability[6] was turned

off by the Clinton administration[7]. This meant that all, not only the US Department of Defense, would have access to much more accurate positioning data for free. One popular early use of GPS was the adoption of geocaching in science and math learning, or the variant ecocaching where the emphasis is on exploring natural or cultural spots in the field. In ecocaching the spot itself is the cache (e.g., a particular botanical species in the field). Other projects are focusing on using location technology to automatically input location data and create contextual adaptive applications and data for field workers (e.g., Pascoe, Ryan & Morse 2000). One larger research effort is the GIPSY project, now continued as the Manolo project (Wentzel, van Lammeren, Molendijk, de Bruin, & Wagtendonk,. 2005), which uses a commercial GIS application adapted for use on small mobile devices. Using GPS technology the students can use the handheld GIS application to navigate to real sites of interests for a particular study topic.

GPS is not the only location technology one can use. The spread of 802.11 wireless networks has lead to several projects that take advantage of this in making innovative new applications. For example, the CatchBob! application (Nova & Girardin, 2004) uses 802.11 location technology in their application as a means for students to navigate and coordinate joint efforts in a game.

This is not an exhaustive list of mobile learning categories, but rather diverse examples of some of the current approaches to using mobile devices in learning. These are examples of novel learning experiences afforded by the mobility, computing, and networking capabilities offered by these devices. We see that new innovations gives new opportunities for pedagogical innovations.

MOTEL for higher education

MOTEL (Mobile Technology Enhanced Learning) is a sub-project within a larger project named TRANSFORM[8]. TRANSFORM is a four-year project focused on productive learning

practice in higher education. In TRANSFORM we take a socio-cultural perspective (Wertsch, del Río, & Alvarez, 1995) on learning where we see learning as an activity mediated by technology and what is actually going on is in focus. Project MOTEL seeks to investigate how mobile technologies can enhance and support learning and research activities in higher education. In the tradition of Scandinavian design research (see for example Ehn, 1993), we take a multi-disciplinary approach to interaction design that is based on a public dialogue with active participation of end-users and is focused on people, societal values, ICT functionality, and aesthetics. As Bannon and Bødker (1991) explain, design is "a process in which we determine and create the conditions which turn an object into an artifact of use. The future use situation is the origin for design, and we design with this in mind … To design with the future use activity in mind also means to start out from the present praxis of the future users (p. 242)". This means that there is a tight connection between design and use and that when we design, we are designing for a future practice, informed by the present. Thus, the current practice of students as they move between their learning venues, is studied with an eye on designing a mobile learning technology (i.e., identifying the role(s) for mobile technology) to support their learning activity as they move between these venues. This is similar to a study carried out by Wasson (1998) where she studied a net-based simulation used by on-campus students in order to inform the design of a future collaborative telelearning environment where this same net-based simulation game would be central.

In this section we first describe the empirical studies we have carried out. Using the results of these studies, we present a number of informed design decisions that we made before presenting the MOTEL framework.

Empirical Studies

In order to learn more about how students presently are using technology throughout the day, we carried out ethnographic flavored field studies where we followed biology students and faculty in their learning/research activities at the University of Bergen, Norway. Interviews were conduced with the student´s and we asked about: the kind of tools (both analog and digital) they used in their learning activities (to get information, to communicate); the kind of digital tools the owned and used in other lifetime activities; and where they used those tools (e.g., at home or in the reading room). The interview questions were motivated by our belief in the importance of leveraging existing resources (e.g., IM, mobile phones, weblogs, etc.) in order to take advantage of them in future learning activities—some of these resources may not be thought of as learning resources by the students themselves, just as a tool for everyday life.

From these investigations we identified the following characteristics of use:

1) Reflecting the mobile society in which we live, both students and researchers frequently change their site of learning including the classroom, home, wet labs, boats, field sites. For this they are in need of something that they can bring across these various sites, or learning venues.

2) Various uses of maps are very important for this discipline. In particular, we identified that most data requires an attached location, most frequently in the form of a coordinate, and maps are used as tools in social interactions, for illustrating purposes in papers and reports, and in analyzing data using for example Geographic Information Systems (GIS). Figure 1 shows an example of map usage. The biologists used the digital map as a resource when discussing findings and planning where to go next.

3) Researchers and students are interested in mechanisms to support sharing of data. For example, when students work together in projects. Ironically, there are some national and international

initiatives to make online databases for sharing material and collections (e.g., species databases), but they are hardly used.

4) Biology is a very technology intensive field and most tools are becoming digital. This is one kind of "convergence" where their cameras (video and still), and all sorts of measuring equipment are now equipped with a digital interface enabling computational manipulations.

Figure 1: Map usage by biologists on an excursion

The results of the empirical studies of the biology students and faculty gave us great insight into a technology rich learning discipline and gave us these four characteristics of use that we feel are relevant for other disciplines as well. Data or information belonging to a location or coordinate (and time/date) is a feature that is also important for subjects/disciplines other than biology. For example, in the study of Norwegian language dialects, the location where a dialect originates or is found today is important or in archeology where artifacts are found is extremely important. Similarly, the use of maps is also an important tool and resource for disciplines such as System Dynamics and Geography.

This led us to a decision that we would design a generic mobile learning framework, and not one for biology in particular. The observed use characteristics provide the foundations for building a more generic application where first and foremost we support the students and faculty

in moving between the different learning venues. Second, it is important that the students be able to actively produce, as well as critical consume, information and content. Thus, we will focus on a system where the user is the main creator and initiator of information and communication. This is in contrast to a more traditional mass communication mode where central content creators makes/broadcasts content to consumers. The result is the MOTEL framework described in the next section.

MOTEL the framework

The basic idea behind MOTEL is to build a mobile application framework for supporting mobile students, instructors and researchers. We see MOTEL as part of a socio-technical infrastructure and an emerging framework for generic virtual annotations. Seeing it as part of a socio-technical infrastructure means that we plan to develop learning activities using the system and that the system must be seen as part of those activities and not as a separate product. This paper, however, focuses on the design and implementation of the MOTEL framework. This section presents in detail the MOTEL framework and application prototypes, focusing on the design decisions that were made.

MOTEL Overview

While mobile support can encompass a whole range of issues, MOTEL focuses on three aspects: 1) geo-tagging used for messaging and data gathering (and for later retrieval); 2) interoperability between various devices (by using platform independent protocols like XML-RPC, and open source development platforms like Java ME); and 3) easy re-use and editing of data (including conversion mechanisms between formats).

A framework for supporting virtual tagging of locations has been developed and usability testing carried out, see figure 2. This framework currently comprises an application for mobile

telephones (an open source j2me application), the use of GPS, and a server back end for receiving and displaying virtual tags overlaid on maps. The application enables the creation of notes and tables, both of which have attached GPS coordinates. These notes can be stored locally or be sent to a central server.

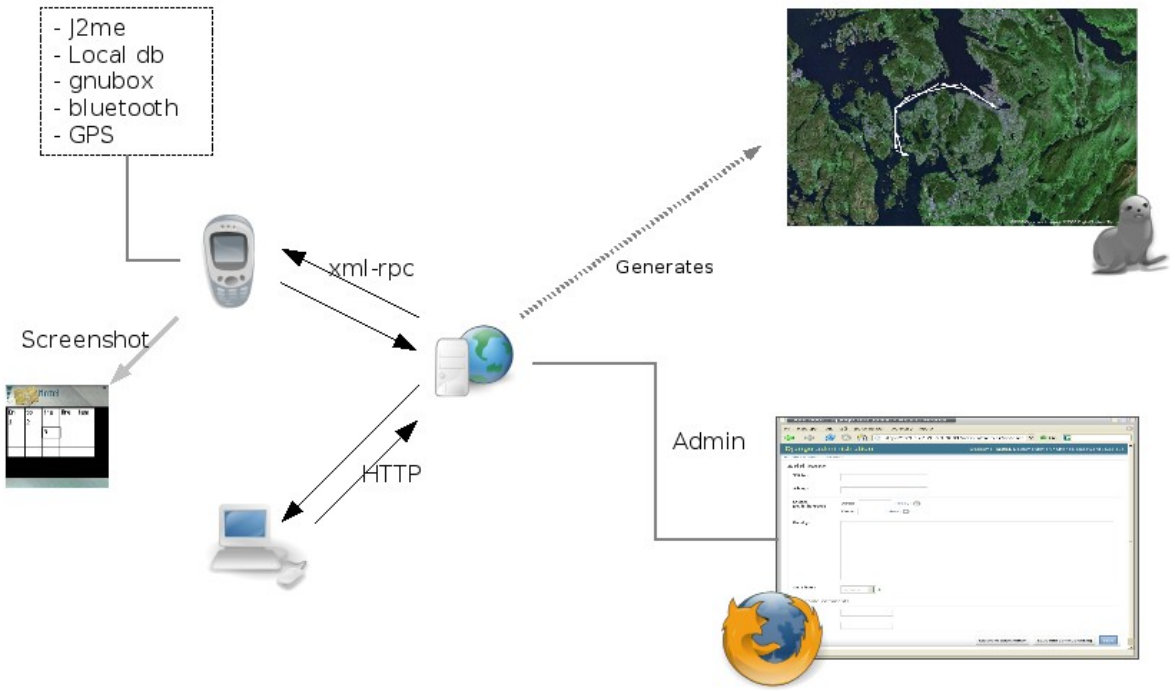

Figure 2: The MOTEL Framework

Targeted device. The mobile phone was the targeted device for the prototype and for future development. The main reasons were: 1) all 13-34 Norwegians own a mobile phone (Ling, 2006), with SMSing being very popular; 2) are truely portable. Laptops are also portable, but are best used on a flat surfaces and a WIMP (Windows Icons Menus Pointers) interaction paradigm normally demands full attention and is unsuitable for “using while moving” (Pascoe et al., 2000). 3) cost - PDA's were also considered they are more expensive than most mobile phones and are

not in widespread use in Norway; 4) mobile phones are always on, or on standby, and present; 5) we believe they have an underused potential in formal settings.

Target development platform. The Java Micro Edition platform was chosen as the development platform for the mobile phone client application because we had experience with it, but more importantly it is both a widespread and portable technology. Other advantages include its further development through the Open Java Community Processes. Java ME has also become Open Source Software so it fits with our philosophy to not support a particular proprietary system. We also considered using Python since we all had Nokia S60 phones that supported Python[9], but although Nokia is the most sold mobile phone make in Norway (and the most sold smartphone in the world) we wanted to support as many makes as possible and found that with Java ME platform we could do that.

Positioning. One of the challenges was how to do positioning in order to attach location meta-data to a note or table. We considered using: 1) cell towers: J2ME has a location API in order to query cell towers, but for the best result you need an agreement in Norway with tele-operators. There are some promising initiatives (e.g., placelab.org and cellspotting.com) but at the point of development they were not an option; 2) wireless base stations (802.11). Access to base stations within the area of interested is needed and if there are no base stations available it is not possible to do positioning at all. If you have access to the base stations a second step of manual calibrating and triangulation is needed. This is however a great option for indoor positioning (e.g., see CatchBob![10]); 3) GPS positioning. GPS is the most used positioning technology used by airplanes, space shuttles, boats, ships and cars. Although its accuracy varies depending on place and device being used, it is considered accurate 'enough' for many applications (varying between 4 and 20 meters), and is very reliable. Is also covers the whole earth, but needs free sight of the sky

—while good at sea, it could be a problem in a highly dense forest, and in some area in cities with sky scrapers; 4) bluetooth base stations. This is an option for controlled scenarios (e.g., inside a museum) when short range is sufficient; 5) Embedding location data in semacodes. This, however, requires the placement of a semacode sticker at a particular location beforehand, and is thus only suited for controlled scenarios. Further, one needs a camera phone to shoot a photo of the code and the application translates the code into a URL. Thus, this is neither automatic nor a quick operation for the user.

We decided to use GPS for the location mechanism and external GPS devices. First, Bergen is cloudy and mountainous so we tested and found many integrated GPS devices poor compared to external ones. Second, mobile Phones with internal GPS devices also use a lot of battery, and third, few students owned a mobile phone with integrated GPS. Fourth, we wanted the users to move freely around in areas without Wireless and cell towers such as high in the mountains or at sea.

Local storage support. Supporting local storage on the mobile phone was a feature we needed to support for several reasons. First, when working with educational institutions it is important that costs are kept to a minimum and the user does not feel restricted with respect to annotating. With a local database functionality the user has the option of deciding later which notes/tables to upload. Second, it is possible to use a your desktop computer to connect to the server and use an existing Internet connection. In MOTEL Gnubox, a Symbian software application that lets you use a bluetooth connection to connect to the Internet using a computer, was used to facilitate this further. ('this it the other way around', the normal way is to use the mobile phone to access the Internet using e.g. a laptop).

MOTEL in action

To explain the functionality of MOTEL, we sketch a possible use case where a group of students are learning about local history exploring Bergen and making notes about historic buildings they encounter (this is similar to the task we had students carry out during the usability testing of the MOTEL application). The group of students needs to divide up in order to cover the city.

Preparation: Each student downloads the MOTEL client application via HTTP or by getting beamed over bluetooth (or infrared). An administrator makes user accounts on a MOTEL server (the client application can be used stand alone but then there is no uploading of notes and tables). The user has a GPS device in her pocket. Then the client application needs to be configured for use with the server and the GPS device; a configuration tool will automatically locate any GPS device close by and present a list from which she picks the GPS device. The student is now ready to begin the exploration of the city.

Virtual Annotating: Whenever the student encounters a historic site she wants to write about in a note or a table, she clicks on add a note (or table) in the client on her mobile and writes the note. When pressing 'save' she will be given the option to save the note with location coordinates attached—and a virtual annotation has been created.

Managing the Notes: Later the student can select from a list, see figure 3, the notes she wants uploaded to the server (needs server authentication). Since the notes (and tables) are saved locally they can be edited and deleted on the mobile before sending them to the server and when cleaning up old notes. It is also possible to wait until she is back at her office and use Gnubox and her desktop computer to send the notes to the central server database.

Retrieving Notes: One interesting feature of the client is the built in note retrieval mechanism. There are two ways to receive notes (both will send a call to the server). First a request for all notes written by a particular group ID (e.g., retrieve all notes written by my group) can be sent to the server. Second, it is possible to retrieve all notes within a radius of X meters (contains very advanced calculations due to how the earth is curved). This, for example, enables the group of students to retrieve other notes by their group that have been posted at the same spot, or near to a spot, or to check if any virtal notes already exist for location she is thinking of writing about.

Route Tracking: If the student wants to track the route she is moving a pointlogger has been implemented. The pointlogger, however, can't be used without continuous network access, as it needs to post coordinates in real time.

Figure 3: Screenshot of selecting a note to be sent to the server

Map Views: On the server side a relational database with an interface written in python and an experimental administrator interface built with the Django framework[11] is being tested. A

set of python scripts generates views of the notes and tables as maps with overlaid notes and tables as clickable hotspots, see figure 4. A script, using the Google Maps API, retrieves their data from the relational database (posted by the mobile phone client). The user can also log on to this administrator interface using a web browser to get access to her notes and tables where she can edit, delete and even add new notes.

Figure 4: Shows an example google map view

MOTEL 2: Future development

Our development work has given us further ideas about how new innovative learning activities can be designed. In the next version we want to make possible richer experiences for the

learner. In order to do so we will focus on three areas. First, we will explore how the various forms of locative technology can be used. In particular, we are interested in exploring how to use cell towers signal strength and ID information in cities. This could mean that the user will not need an GPS device when using the system. Second, we will implement and experiment with geofencing. Geofences are virtual fences that trigger actions or guide the user when entering or leaving a specified area. Third, we want to support crossmedia, to provide students with the possibility to use various media in learning and communication. This involves making it possible to post multimedia to the system and making mechanisms and clients for devices other than J2ME enabled mobile phones. This we believe is an important issue to be aware of when developing educational applications for the future when the range of digital devices owned by students will vary more than ever.

Mobile learning revisited

One thing in particular that has changed in recent years is the range of different mobile digital devices on the market and in possession and use among the general population. It is not only the computer, as in a desktop or workstation, which is the main digital tool in use. There is a plethora of digital appliances and devices (or 'information appliances' as Donald Norman envisioned them) including portable computers (laptops and ultra portables), PDA's, mobile phones (with various degrees of sophistication), digital cameras, digital GPS units (Global Positioning System), small portable game consoles (e.g., the Sony PSP or the Nintendo Wii), personal media assistants (e.g., Archos devices), etc.

We also see convergence. Digital devices are merging or adding features to their base—digital devices become multi-functional devices. Mobile Phones become mini computers (e.g.,

Symbian OS based phones) and in addition to being a game console, the new Sony Playstation 3 will be your new computer and home entertainment centre.

This leads to crossmedia communication and production. Today you can use Google maps on your mobile, Flickr, the largest picture sharing site, has made it possible to post photos using your mobile, and Instant Messaging clients are available for mobiles and game consoles. As a result, there is an ecology of online communities creating new services and technologies; commercial companies, hacker communities (gluing together existing systems, extending the use), and user communities provide feedback on design and participate in envisaging alternative/new uses and services.

What are the implications of these trends for mobile learning and for learning in general? We believe that these developments change the premises (the tools and practices) and conditions for learning activity. Our research is motivated by how to make a productive learning infrastructure around these emerging mobile devices and practices This means the challenge is to both understand the changing conditions for learning and be aware of the affordances of the technological in order to harness the synergy of these.

In the next months we are field trialing the application. Important questions we are asking include: How can knowledge about how students and professors organize their learning activities (and their life in general) and how they utilize technology be used in a meaningful way? How can we leverage existing knowledge among students and professors in order to facilitate and guide students and professors in taking new and existing technology into use? How can we build learning infrastructures that leverage on existing knowledge and takes new and emerging technology into account? What role should the mobile technology take ? Where should the learners attention be, on items in the application or outside the application such as a building?

How artefact's and mobility are pivotal to productive learning, and how to enhance and support learning activities.

References

Baggetun, R. (2006). MOTEL: Mobile Technology Enhanced Learning. Poster presentation at Kaleidoscope NoE Mobile Learning Initiative Workshop on "Big Issues in Mobile Learning". Thursday 1st June 2006. Nottingham, UK

Bannasch, S., and Tinker, R. (2002) Probeware takes a seat in the classroom: educational impact of probes improves with time and innovation. @Concord 6:1 p. 7. Retrieved November 2006 from http://concord.org/newsletter/2002winter/probeware.html

Bannon, L. J. & Bødker, S. (1991). Beyond the interface. Encountering artifacts in use. In J. M. Carroll (Ed.), Designing interaction: Psychology at the human-computer interface, 227-253. Cambridge, UK: Cambridge University Press.

Bolter, J. D.(1984): Turing's Man. Western Culture in the Computer Age. Chapel Hill: The University of North Carolina press.

Colella, V. S. (1998). Participatory Simulations: Building Collaborative Understanding through Immersive Dynamic Modeling. Master thesis MIT

Ehn, P. (1993). Scandinavian design: On participation and skill. In D. Schuler & A. Namioka (Eds.) Participatory design (pp. 41-77). Erlbaum.

Kay, A C. (1972). A Personal Computer for Children of All Ages. Xerox Palo Alto Research Center

Klopfer, E., Squire, K., & Jenkins, H. "Environmental Detectives: PDAs as a Window into a Virtual Simulated World," wmte , p. 95, 2002.

Ling, R. (2006). The role of mediated ritual in mobile communication. Guest lecture at InterMedia, UNIFOB. July 7th 2006.

Pascoe, J., Ryan, N., and Morse, D. 2000. Using while moving: HCI issues in fieldwork environments. ACM Trans. Comput.-Hum. Interact. 7, 3 (Sep. 2000), 417-437. DOI= http://doi.acm.org/10.1145/355324.355329

Rekkedal, T., Dye, A., Fagerberg, T., Bredal, S., Midtsveen, B., & Russell, J (2005) Design, Development and Evaluation of Mobile Learning at NKI Distance Education 2000-2005.

Rheingold, H (2003) Smart Mobs: The Next Social Revolution. Published by Basic Books

Rogers, Y., Price, S., Fitzpatrick, G., Fleck, R., Harris, E., Smith, H., Randell, C., Muller, H., O'Malley, C., Stanton, D., Thompson, M. and Weal, M. (2004) Ambient Wood: Designing new forms of digital augmentation for learning outdoors. In Proc. Interaction Design and Children, ACM, New York. 3-10

Säljö, R. (2002). Lärande i det 21:a århundradet. In R. Säljö & J. Linderoth (Eds.): Utm@ningar och e-frestelser. It och skolans lärkultur (pp. 13-29). Bokförlaget Prisma, Stockholm.

Spasojevic, Mirjana & Kindberg, Tim (2001). A Study of an Augmented Museum Experience. HP invent Technical Reports. HPL-2001-178. 20010726. Retrieved November 2006 from http://www.hpl.hp.com/techreports/2001/HPL-2001-178.html

Wasson, B. (1998). Identifying Coordination Agents for Collaborative Telelearning. International Journal of Artificial Intelligence in Education, 9, 275-299.

Wentzel. P., van Lammeren, R., Molendijk, M., de Bruin, S., & Wagtendonk, A. (2005). Using Mobile Technology to Enhance Students' Educational Experiences. ECAR Case Study 2, 2005. Case Study from the EDUCASE Center for Applied Research.

Wertsch, J. V., del Río, P. & Alvarez, A. (1995). Sociocultural studies: history, action and mediation. In Wertsch, J.V., del Río, P., & Alvarez. A. (Eds.) Sociocultural Studies of Mind, 1-34. Cambridge: Cambridge University Press.

Wilensky, U. and Stroup, W. 1999. Learning through participatory simulations: network-based design for systems learning in classrooms. In Proceedings of the 1999 Conference on Computer Support For Collaborative Learning (Palo Alto, California, December 12 - 15, 1999). C. M. Hoadley and J. Roschelle, Eds. Computer Support for Collaborative Learning. International Society of the Learning Sciences, 80.

Author Notes

This research is part of the TRANSFORM project. TRANSFORM and Rune Baggetun´s Ph.D stipend is funded through a research grant from the Norwegian Research Council.

Footnotes

1 http://foto.no/cgi-bin/bildegalleri/index.cgi

2 More than 30% of all Norwegian own a portable audio player and the number is rising. Source http://www.ssb.no/emner/07/02/30/medie/art-2006-03-23-01.html

3 http://en.wikipedia.org/wiki/Tamagotchi

4 In Norway 57% of all boys and 23% of the girls (9-15 years old) are playing games each day

5 This is an application for small devices used to subscribe to content from a particular content provider, including educational content providers.

6 http://en.wikipedia.org/wiki/GPS#Selective_availability

7 http://www.ngs.noaa.gov/FGCS/info/sans_SA/docs/statement.html

8 http://transform.intermedia.uib.no

9 http://opensource.nokia.com/projects/pythonfors60

10 http://craftwww.epfl.ch/research/catchbob

11 http://www.djangoproject.com

RUNNING HEAD: TERRA INCOGNITA 4 – THE EUROPEAN ADVENTURE

Terra Incognita 4-The European Adventure: a collaborative, affective-aware, SMS and web-based learning system

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Abstract

In this paper we present a hybrid SMS and web-based game-like learning system. We designed and practically proofed the SMS and web-based four tier system. Our main goal was to provide a community information service that implies the ability to work with PCs and mobile phones, proactive attitude in searching for information, knowledge acquisition and sharing about the European Union, in a pleasant learning environment. The three-month project hosted around 2000 gamers that had a minimum 10 days virtual journey in the European cities. The results are good and are detailed in the article. Almost all participants that responded to the questionnaire are willing to continue to play a similar kind of game.

Terra Incognita 4-The European Adventure: a collaborative, affective-aware, SMS and web-based learning system

Introduction

In our scenario the user is represented by an alter-ego (gnome) that is wandering in a virtual space. The user receives from his avatar a description followed by a question adequate to its location. The next location can be automated or requested at free will (teleporting). A smiley face that changes according to the user's carefulness towards his avatar represents the gnome's mood.

The problems

The general problem that we have tried to solve was: "How can we develop an community information service that implies the ability to work with PCs and mobile phones, proactive attitude in searching for information, knowledge acquisition and sharing about the European Union, in a pleasant learning environment?"

More specific we had:

A. A didactic problem "How to design a web-based and mobile accessible learning platform to motivate young people learn about European Union? "

B. A technical problem "How to design a computational and communication system that manages information and questions on European cities and the answers from a big number of users using web-based and mobile interfaces."

The collaborative, affective-aware, SMS and web-based learning system

The learning environment design

First of all we developed a database content for 73 cities from 29 countries: the 25 members of the U.E., and Romania, Bulgaria, Turkey şi Croatia (candidate states). Initially there

have been developed 1200 subjects from different domains and then some other where added by the „Gnome's Word" feature. In the initial set the European Union (institutions, politics, funds programs, symbols etc.) information had a 30% representation. The rest of the content items promoted the European space life style, culture and values, cultural diversity and local traditions of the European people. The domains of interest where:

Economics/Politics (Public politics/Work opportunities)

Travels (How to get there/Lounge/Food)

Lifestyle (Fashion/Lifestyle/Clubs)

Music (Pop/Rock/Electronic/Classic)

Nature (Ecology/Trekking)

Education (Educational System/Study Opportunities/Voluntaries Opportunities)

Civilisation (History/Culture/Traditions)

Digital Culture (Information Technology/Communication/Events)

Arts (Plastic Arts/Spectacles)

Sports (Teams/Events)

Mix (others).

The second concern was to develop a strategy to increase the targeted group of young people ranging from 15 to 30 years old the motivation to learn about the E.U. Some important feature where designed to fulfil this scope:

- The game-like design of the platform stimulating the competition between individuals and teams;
- Chatting with other players and gamers' discussion forum to improve the communication between the participants;

- Avatars affective states where displayed and modified according to use carefulness in a range of 10 degrees from unhappy to extreme happiness, based on the persona effect (Lester, Converse, Kahler, Barlow, Stone, Bhogal (1997)) (see figure 1);

Figure 1

- Teleporting - the player's possibility to "move" the avatar to a new location besides the ones that were automatically generated;
- Advice – the possibility of the players to ask for advice or to give advice to those soliciting it.
- "Gnome's Word"- a superior module which allowed the players to propose their own subjects, to add information and questions to the already existing database, after being authorized, checked and completed by the administrator

<u>The technical architecture</u>

We proposed a 4-tier architecture where the components are: the graphical user interface, the database, the game engine and the short messages server.

The graphical interface was designed in Macromedia Flash [] like a game gear console (see figure 2) with a picture of the actual location of the avatar and main features interfaces.

Figure2

The database used a MySQL database (22 tables) linked to Flash by AmfPHP. Because the web-based interface had a different location then the SMS-server a second database had to be used on the second one, with a reduces number of tables (5 tables). The two databases where synchronized by a Java application once in 60 seconds.

The game essentially consisted of a player participating at a repetitive cycle of questions and answers. So, the game engine worked as follows:

In each cycle the player's avatar would report from a given location and ask the player a question at the end of its report. The question would have to be answered by the player (a correct answer would add a certain number of points - the player's score), and then the avatar would go idle and wait for deployment into another location. There were two possibilities to trigger this deployment: either by “Teleporting” the avatar (sort of chasing him around the cities of Europe) or by waiting till the avatar would get the desire to move by itself.

If the player did not answer the question the avatar would move to another location by itself after a certain time.

Whenever an avatar reached a new location by “Teleporting” the question posed to the player would be a "regular question" worth 2 points plus 50 teleport bonuses. Teleport bonuses were limited to 200. Each time an avatar reached a new location by itself the location would be considered a key location and the question would be worth 50 points. A player would play the game until its avatar reached 30 key locations.

Example 1: A lazy player would just leave his avatar travel around by itself and receive the key questions by e-mail or SMS without ever logging in to the game interface. Should he answer these questions or should he just ignore it, the avatar would get on with its journey, though less and less happy. Interaction with its owner and correct answers would make the avatar happier again. If his happiness decreased under a certain limit, the avatar would send complaint SMS-es to its owner saying "I feel ignored... please give me more attention." If the player did not react, the avatar would leave the player saying: "You ditched me, I ditch you".

Example 2: An active player would play the game mostly through the game interface offering more interaction possibilities with other avatars/players (e.g. high scores/news, chat,

forum). A typical active player would teleport its avatar to new locations, answer to the non-key questions then let the avatar rest so it will travel on its own again after a certain time.

In designing the SMS server (see figure 3) we evaluated:

1. The minimum time duration for one short message management (received or sent)
2. The number of mobile devices needed to work in parallel.

Figure3

For the minimum time duration when a SMS is sent we experimentally estimated a maximum of 20 seconds. Different values where obtained varying according to connection method (serial or USB port, data cable or Bluetooth) or connectivity settings values (bitrate). Even if some better time duration where obtained when using a higher bitrate (i.e. 921600 kbps) due to phone management software problems experienced later we chose to use the 9600 kbps bitrate as the time advantage could be of only 15%. Regarding the connection method thee data cable seemed to be less time consuming (15% gain), cheaper and safer then Bluetooth. The IrDA method was not suitable as the mobile to PC link could be broken due to misalignment or short time maintenance of the IR beam in the mobile phone.

In order to compute the number of mobile devices needed to work in parallel we know that:

- The total number of messages for the whole period was: 270 000
- One mobile phone can manage more then 3 messages in one minute, that is 180 SMS per hour and 2160 in the minimum12 hours of activity of a day
- The needed mean number of messages per day was 270 000 / 45 = 6000. Supposing that in the peak period we can reach on increase with 25% of the total number of

messages per day (7500) we calculated the number of mobile phones as: 7500/2160=3.472 that can be approximated to 4.

Results

A. Learning system

The interactive campaign took place between 18 April and 5 July 2006 (78 days), more then previously intended (45 days). As general results we mention:

- Number of users: 1811
- Number of teams: 221
- Number of players in a team: 2.8
- Total number of subjects per visited destinations: 235469
- The mean number of subjects per player: 130 (5 times more then the initial number of subjects)
- Correct answers: 149900, representing 64% from all the answers, to each question not answered correctly the good answer has been given
- The mean number of advices given/received by the player: 5,5
- Advice correctness: 82%
- The number of site visits: 43874
- Unique visitors (by IP address): 28492
- The number of visits exceeding one hour: 9596

The features in the learning platform had the following results:

- *Chatting* with other players and gamers' discussion forum helped players develop a strong community. While discussions were always centered on the game features, the

full range of human relationships developed on the forum and kept the players emotionally involved. Thus players would watch each other's evolutions, argued about correct/incorrect answers, cheat possibilities and so on. The human dimension attained by human-human interaction on the game forum proved to be much deeper than relationships between gamers and avatars. Although estimated to be of heavy use, the chat engine did not stir relevant interest.

- *Helping each other* - If one player did not know the answer to a question posed by its avatar he could ask for help. Then all the gamer community would see his avatar in trouble and advise him to take this or that option. Advising an avatar in trouble would bring credibility points to the advisor. Increased credibility would contribute to the avatar's happiness. Players advised would see the credibility rate of their ad
- *Teaching the avatar* - Another game module available to those who played the game online rather then by mobile phones was the "Teach" module. Players could teach their avatars new things about European cities. The new information would enter the general knowledge pool, enriching the content base the players would browse during the game. If an avatar stumbled across a piece of information its master submitted, it would by default know the correct answer, get all the bonus points at stake and go on with its trajectory.

One interesting observation regards cheating or finding backdoors. Several players found a method to get extra points: they would create multiple accounts, and use these as "slaves" i.e. keep asking for help on their behalf then answering the questions with the "master of slaves" avatar. 3 weeks into the game it was necessary to revise the helping/hinting algorithm and to forbid players to give subsequent advices to the same small number of avatars.

When the participants finished the game they where asked to fulfil an exit poll. A number of 78 persons responded. The following resumes their opinions:

- I have learned new things about the European Union – 62% of the responders answer with „much" and „very much"
- I have learned new things about the European countries – 77% of them say with „much" and „very much"
- The relevance of the locations for the European cultural space – 75% answer with „much" and „very much"
- I liked to play „Aventura Europeană" („The European Adventure") – 81% of the exit poll participants say „much" and „very much"
- The experience of the virtual exploration was useful for me – in 75% they say „much" and „very much"
- I have improved my technological abilities – 27% answered with „much" and „very much".

The features of the platform have been also object of the questionnaire. The results may be seen in the following table:

Table 1

We may observe the impressing impact of "Teleporting" compared to other features like, for example, "Playing by SMS". We think this happened especially because many of the gamers where very passionate in getting as much points as possible and less on the social, cultural mobile access aspects of the learning platform.

B. Technical results

The system's most important issue that we had to solve in the test period was that from time to time, without any obvious reason, the mobile phones crashed one at a time. A mobile phones web-based monitoring system had to be set-up in order to guarantee that the messages will be delivered, even if will some delay.

In the last days of the game as the number of users decreased we decremented the number of messages interrogations from the PC to phone per minute. As a result, the number of crashes decreased significantly. We concluded that an adaptive system that estimates the right value for the number interrogations per minute could be desirable for a future implementation.

Related work

This learning platform integrates well-known e-learning features as forum and chats and is a web-based game like learning system. Some new feature are integrated like the playing by SMS, the avatar' affective state display, teleporting and "Gnome's Word" even if these are not new on their one.

There are some other SMS-based learning systems like the one presented by Stone (2004) where blended learning is used. The general disadvantages of SMS as described by Shudong and Higgins (2005), that are: the low number of characters (160 in a message), the difficulties in inputting by pressing the tiny keys are solved here as the answer consists in just one letter answer and the cost of the message has a normal tax.

The affective state of the avatar uses the persona effect discovered by Lester, Converse, Kahler, Barlow, Stone and Bhogal and is similar to the Tamagotchi handheld digital pet (www.tamagotchi.com). The only affective state is happiness ranging from low to high intensity (see figure1, where each column from the first 4 columns illustrate the extreme happiness of the same avatar, and the last 4 columns are the opposite- absence of that state).

Acknowledgements

The project "Terra Incognita 4. Aventura Europeana" was co-funded by the European Union through the Phare Program, Europa Fund and the interactive campaign took place from April to July 2006, Grant EUR 2004 – 08 / 108924, budget line 22.02 06 00.

We thank to sponsors, media partners and all people involved in the project, to those who answered the exit poll and to the players.

Conclusions

We designed, developed and tested a web-based and SMS-accessible learning platform that stimulates involvement and encourage competition and proactive learning by using different features. In terms of mobile access we will redesign it such to allow providing links in the short message text and even to receive multimedia messages (MMS), XHTML based interface for mobile internet browsers for supporting the proactive features like teleporting and "Gnome's Word" use from the mobile devices, too.

References

Lester, J.C., Converse, S.A., Kahler, S.E., Barlow, T., Stone, B.A., Bhogal, R.S. (1997). *The persona effect: affective impact of animated pedagogical agents*, CHI 97, Atlanta, Georgia, United States, pages: 359 – 366, ISBN 0-89791-802-9

Shudong W., Higgins M. (2005). *Limitations of Mobile Phone Learning.* Third IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE 2005), Tokushima, Japan, ISBN 0-7695-2385-4.

Stone, A. (2004). *Blended Learning, Mobility, and Retention: Supporting First Year University Students with Appropriate Technology*, MLEARN 2004, Bracciano, Italy.

Table 1

The learning platform features evaluation in the exit poll

Feature's usefulness	Very little	Little	Moderate	Much	Very much
Gnome's affective state	19%	9%	17%	31%	24%
Playing by SMS	18%	24%	15%	26%	17%
Teleporting	3%	1%	6%	23%	67%
Gnome's Word	13%	8%	22%	31%	26%
Advices	12%	12%	14%	31%	31%
Forum	12%	18%	27%	28%	15%
Chat	26%	22%	22%	18%	10%
Group	31%	13%	28%	14%	14%

Figure Captions

Figure 1. Four different avatar faces displaying happiness degree (high on the four left columns and low on the right four columns)

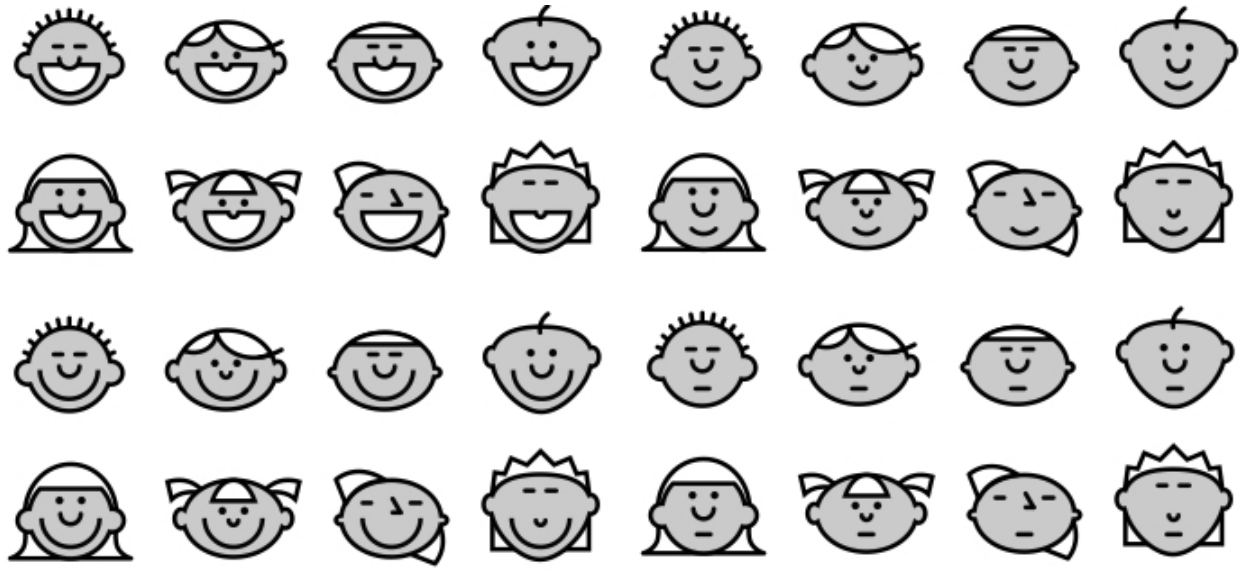

Figure 2. The player's graphical interface

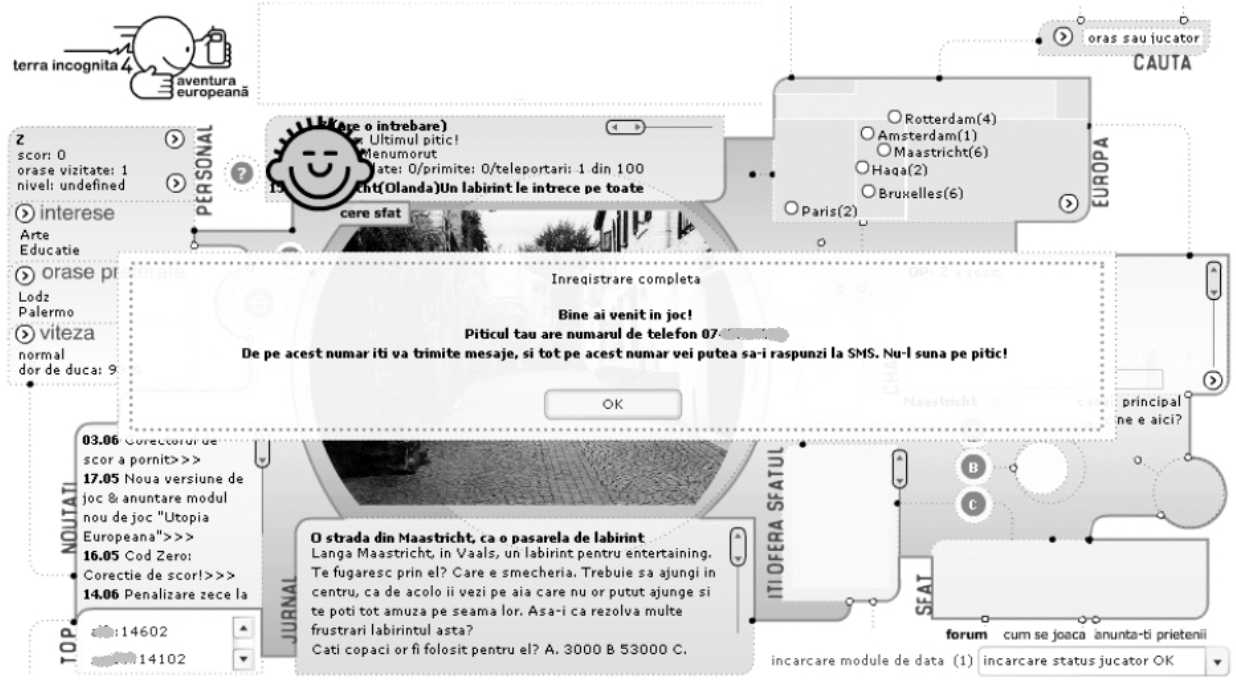

Figure 3. The mobile phones connected by data cable to the server computer


1
2
3
4
orange
Silent
1 message
received

Developing multimedia mLearning for mobiles

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Abstract

This short paper presents a prototype multimedia learning object that has been developed for the mobile phone. It outlines the rationale for this work and then discusses the issues raised and the design solutions that resulted during the development process. It concludes with an overview of where this work is going, and some of the issues that need to be faced to make multimedia mobile learning objects available to students.

Introduction

The ability to produce effective multimedia learning applications for technology that is ubiquitous is very appealing. Mobile phones are becoming more technically sophisticated. They can create and play multimedia content: they have larger, high quality, colour screens; many models can now capture, edit and play back video, audio and photographs, and can run Flash-based interactive applications (through Flash Lite). They also have greater storage capacity and networking connectivity, can connect to the Internet and PCs, and have Bluetooth and WIFI. Surveys conducted with University students in October 2005 and February 2006 show that they own mobile phones that have multimedia and connectivity capabilities in increasing numbers (Cook et al, 2006). Harnessing the use of these devices for multimedia learning resources which are known to engage and motivate students (e.g. Boyle, 1997) could be a powerful way of providing learning materials to students who increasingly have other demands in their life and on their time and need more flexible learning solutions.

This short paper discusses developments that build on our previous work in developing multimedia learning objects, and our initial work into mLearning, in which we produced multimedia learning applications for the PDA (Bradley, Haynes & Boyle, 2005a). It explores the next step on the continuum, in designing learning resources for a more ubiquitous and portable device, the mobile phone. An existing learning object on Referencing Books was chosen for adaptation for the phone. This was chosen as it was a small and self-contained learning object that could be worked through in a few minutes, and was thus considered suitable for mobile learning, where short, bite-sized resources are most effective. The content development had already been done, and this simplified our task to re-designing this content so that it was appropriate for and took advantage of the characteristics of the phone. Our ultimate aim is to develop multimedia learning content for mobile phones, which is interactive, highly visual, engaging and effective for the learner, using Flash Lite version 2 for authoring and delivery (Flash Lite is a version of Flash for mobile phones). Small, self-contained learning objects that can easily be used by the student whenever they want to use them, wherever they are when they have the desire or opportunity to engage in some learning, taking advantage of this ‘always there, always on’ technology.

Design issues and solutions

We have started by adapting an existing learning object, to see what is feasible and effective on the mobile phone, in particular the Nokia N70. We decided to focus on one popular model of phone initially, in order that we can research the development and design issues involved and find solutions without needing to become involved in the wider technical issues inherent in developing applications that will work on a range of phones with different technical specifications and operating systems.

We had some initial concerns about the nature of the phone that might constrain our design and have a negative impact on user navigation, interaction and control of the learning resource. Crucial issues of application navigation, interface design and content breakdown had to be tackled. Screen size is smaller than we are used to designing for: 176 x 208 pixels on the Nokia N70, about the size of a matchbox. Input devices are limited: there is no keyboard, mouse, stylus or touch screen. Input and selection has to be controlled by the phone's keypad (the keys can be seen in Figure 1). The N70 has 2 'soft keys' at the top left and right, directly under the screen, and these can be programmed to perform specific functions, such as 'exit' or 'back'. In the middle is the 'five-way scroll key', which provides navigation in 4 directions (up, down, left, right) and a button in the middle to select items. User interactivity and selection is a more lengthy process on the phone, as you can't just point and click as you can with a mouse or a stylus. Selecting a button or area on the screen is a 2-step process. First you have to highlight the item by navigating to it, and then you have to use the 'select' key to activate it.

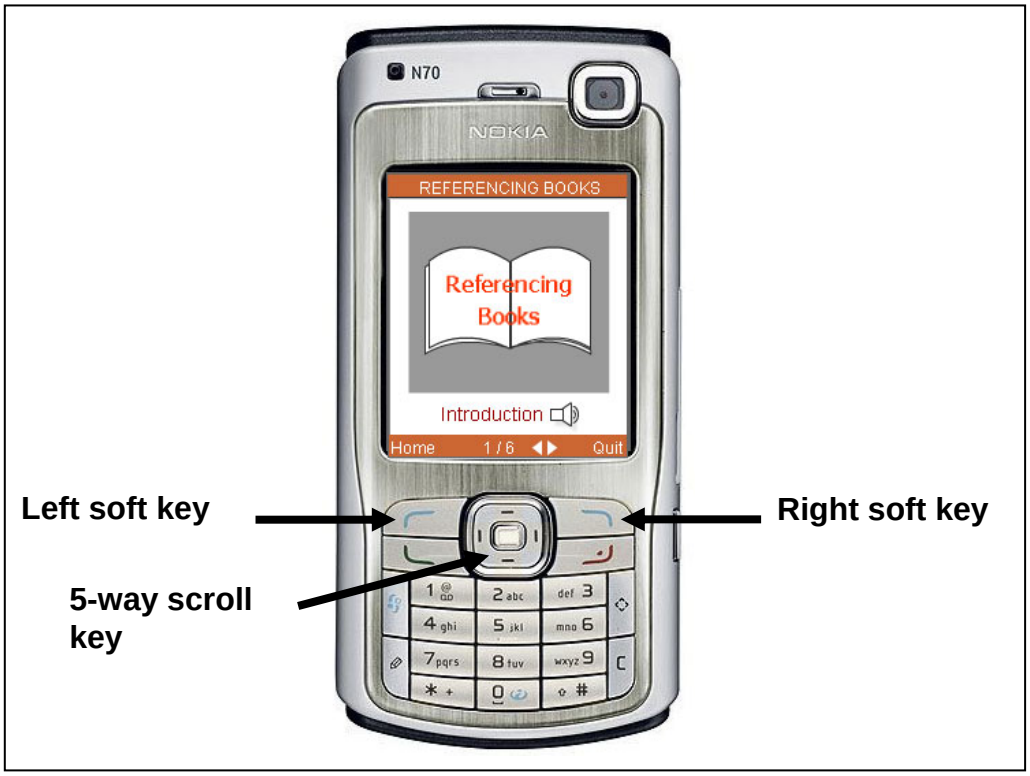

Figure 1: The Nokia N70 phone displaying Referencing Books

We were confident that Flash Lite 2 would be able to handle all the media components included in our learning objects (text, graphics, animations, videos and quizzes), but a number of tests were conducted to ensure that the desired functionality and performance could be achieved on the phone. Text could either be embedded within the Flash movie, or loaded in from an external XML file. Graphics needed to be in PNG format, and simple animations performed perfectly. Video files had to be converted into 3gp format, but there are free conversion programmes available from Nokia, that optimise the video file for the phone (Nokia Forum website). Self-test quizzes with feedback and scores could be included, as Flash Lite 2 supports ActionScript 2 and could provide this functionality.

The next stage was to tackle the issues of the user navigation controls. We looked at other applications that had been created in Flash Lite to identify if there were any emerging conventions. Examples are available from Adobe's website in the Adobe Flash Lite Exchange (Adobe website, a), although these are mainly games, and we also looked at tutorials created by Nokia for the N70 and N91 phones. We specifically looked at the functionality assigned to the 2 'soft keys'. The left soft key was used for a variety of functions such as 'menu' 'start' 'pause', and the right soft key was commonly used to 'quit' or 'exit' the application. We decided to use the left key for 'home', to go back to the beginning of the resource, and the right key for 'quit', to end the resource. We also found out that we could give 'focus to' or highlight items on the screen, such as icons and navigational devices such as arrows and areas of text. This functionality could effectively be used to help users navigate through the object, and make the selections of their choice.

To keep our Flash Lite designs modular, we designed a template for the build. This built on the guidance available at Adobe's website on Getting Started Developing for Flash Lite and the Macromedia Flash Lite 2 Content Development Kit (CDK) (Adobe website, b). The template had the chosen screen dimensions (176 x 208), the background colour (white #FFFFFF), and an outline border to the page. This basic template was enhanced by navigation controls and common elements such as the title bar and the navigation bar, and the addition of basic action scripts. This included FSCommands for displaying the application in full screen, specifying quality, and _focusrect to remove given button highlights. Functions were added for the playing of external mp3 files, setting the page number (e.g 2/6), and the loading of 3gp video and xml text. The template therefore contained all the common elements that could be used for creating other Flash Lite 2 objects.

After we had researched and found solutions for the interface, navigation, use of the phone keys and designed the basic template, we began to develop the content of the learning object. An outline storyboard was developed, based on a thorough analysis of the existing PC-based object and how the content could most effectively be adapted for the mobile phone, and for use in mobile situations. One of the key considerations of this re-design process was the size of the screen (176 x 208 pixels). We learnt from our prior work in designing learning objects for the PDA that smaller screen sizes are not necessarily a design constraint (Bradley, Haynes & Boyle, 2005a). You just have to rethink the problem and find alternative solutions. One of these is to replace lengthy pieces of text usually used for instruction and guidance with short audio clips. This use of audio not only alleviates screen overcrowding, but is easier for people to assimilate in mobile situations. Our research has shown that students also find it easier to learn from audio (Bradley, Haynes & Boyle, 2005b). As the storyboard was developed, scripts for audio instructions and guides were drafted. These were then quickly recorded on an MP3 player, and passed to the developer to incorporate as 'guide' tracks as the resource was authored. They

would be more professionally recorded at a later stage when we were happy with the overall design and the efficacy of the scripts. Another solution for designing for the mobile phone is to present the content in small bite-sized chunks, over a larger number of screens. What would have been presented in one screen on the PC, was broken down into a greater number of steps over several screens. Creative alternatives were found for the presentation of content on the phone, so that it would fit on the screen and still be usable. An example of this is the 'How to reference' section. The PC version uses a large step-though 3D animation. For the phone, this was replaced with a simple step-through still-frame animation, resembling a cartoon strip. This solution reflects a change to a slower pace, where each screen is a cell in the animation. Where the PC resource has text introductions to each new screen, the mobile version has an audio introduction, which is given focus when user enters that screen. In the quiz, to avoid text feedback from cluttering the screen, the feedback was put on a second screen.

Figure 2 shows one of the screens and the interface design from the Referencing Books prototype. There is a title bar at the top of the screen, giving the title of the learning object. The bar at the bottom of the screen is for navigation and orientation. A 'Home' label is on the left-hand side above the left soft key, and a 'Quit' label above the right soft key. In the middle the user can identify which screen they are on within the object (in this case 2/6 – 2 out of 6), and there are left and right arrows to navigate to the previous and next screens. Above the navigation bar, the topic of the screen is displayed, and if there is an audio introduction, there is an icon to play the audio clip. The main area of the screen is reserved for content presentation. When the user enters a screen, if there is an explanatory audio clip, the audio icon is highlighted (given focus), and can be played by pressing the select button. In this screen, after listening to the audio, the user navigates to each of the text labels and selects them to hear a short audio clip that explains why they should make references in their written work. On completion of the screen, the user navigates down to the right arrow at the bottom of the screen, which will become highlighted, and presses the select button on the phone to move to the next screen.

Figure 2: A screen from 'Referencing Books' on the Nokia N70

Conclusions

We have now got to the stage where we have developed a fully functional prototype, and have researched and tackled a lot of the issues involved in developing multimedia Flash Lite 2 learning resources for the N70. Next we plan to trial some alternative navigation strategies, so

that we can be sure that we have got this right. The next stage will be to conduct evaluations and usability studies with target students and peers to get user feedback on our design.

We also have to investigate and tackle a number of issues associated with how we could make such learning objects available to students. Do enough students have compatible phones to make the production of mobile learning objects a viable proposition yet? There are issues around how content would be presented on phones with different screen display sizes and resolutions (which currently varies widely). How do we deal with the licensing costs of downloading Flash Lite, and would students be prepared to foot the bill for this? Flash Lite version 1 now comes pre-installed on a number of phone models, but we have been working with Flash Lite version 2, which supports the authoring functionality of Flash 8, and has to be bought from Adobe at a cost of about $10 (£7), and installed onto the phone. We have to determine how we can best package up the learning objects for easy transfer onto the phone (the current prototype consists of one SWF file, and a series of external assets for the audio and text files). And then determine how we could make available the packaged files for users to have on their phone e.g. by providing pre-installed SD or memory cards, by downloading from the Internet (a cheap option if it can be done via WIFI), transferring them via a PC, or sending them via Bluetooth. There are also opportunities to embrace the strengths that the phone can bring to mobile learning, for example in combining multimedia learning content with scenarios for learners to capture and contribute media files, dynamically upload content on the move, and communicate with peers and/or tutors. We have already found that we can build in the functionality within a Flash movie for users to make a phone call or send an SMS message, which could be used to contact a tutor, or have a discussion with another learner whilst they are accessing a learning object. The possibilities for incorporating multimedia learning resources into sociable learning scenarios on mobile phones is achievable, and that is one of the directions that we are interested to pursue in the next phase of development.

Acknowledgments

Debbie Holley and Carl Smith were also involved in the development of the Referencing Books learning object for the PC.

References

Adobe website a. *Adobe Flash Lite Exchange*. Retrieved November 9, 2006, from http://www.adobe.com/cfusion/exchange/index.cfm?view=sn310#loc=en_us&view=sn310&viewName=Adobe%20Exchange&avm=1

Adobe website b. Getting Started Developing for Flash Lite. In *Mobile and Devices Developer Center*. Retrieved November 14, 2006 from http://www.adobe.com/devnet/devices/flashlite.html#cdk

Boyle, T. (1997). *Design for multimedia learning*. London: Prentice Hall.

Bradley, C., Haynes, R., & Boyle, T. (2005a). Design for multimedia m-learning: lessons from two case studies. In Cook, J. and Whitelock, D. (Eds.) (2005). *Exploring the Frontiers of E-Learning - Borders, Outposts and Migration. Research Proceedings of the 12th Association for*

Learning Technology Conference (ALT-C 2005). Held 6-8 September 2005, the University of Manchester, England.

Bradley, C., Haynes, R., & Boyle, T. (2005b). Adult multimedia learning with PDAs – the user experience. In *Conference Proceedings, Full papers delivered at mLearn 2005*, 25-28 October 2005Cape Town, South Africa.

Cook, J., Holley, D., Smith, C., Bradley, C., & Haynes, R. (2006). A blended m-learning design for supporting teamwork in formal and informal settings. In *Proceedings of Mobile Learning 2006*. Held July 14-16, Dublin, Ireland.

Nokia Forum website. (n.d.) Nokia Multimedia Converter 2.0. Retrieved November 14, 2006 from http://www.forum.nokia.com/main/resources/tools_and_sdks/listings/media_tools.html

Coordinating Networked Learning Activities with a General-Purpose Interface

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Abstract

Classrooms equipped with wirelessly networked tablets and handhelds can engage students in powerful collaborative learning activities that are otherwise impractical or impossible. However, the system must fulfill certain technological and pedagogical requirements such as tolerance for latecomers, supporting disconnected mode gracefully, robustness across dropped connections, promotion of both positive interdependence and individual accountability, and accommodation of differential rates of task completion. Two approaches to making a Tuple Space-based computer architecture for connectivity into an inviting environment for the generation and creation of novel coordinated activities were attempted. One approach made the technological "bones" of the system very clear but assumed user vision of the complex goals and settings of real education. The more satisfactory approach made clear how Tuple Spaces matches the complex goals and settings of real education, but backgrounded technical complexity. This approach provides users with a system, Group Scribbles, which may inspire a wide range of uses.

1. Introduction

Classrooms equipped with wirelessly networked tablets and handhelds can engage students in powerful collaborative learning activities that are otherwise impractical or impossible. . A networked classroom can support real-time formative assessment for teachers (Abrahamson, 1999) as well as activities such as interactive role playing, joint concept mapping and group critiquing. To date, research and development in mobile learning has focused mostly on single-purpose tools in support of particular activities. A more desirable solution would be a general-purpose system that can play a range of roles, so that teachers and students need only learn and invest in one primary kind of classroom connectivity.

The purpose of our research was to identify characteristics of computational platforms that not only enable the implementation of coordinated networked learning activities but inspire the design of activities with high pedagogical value. This goal led us to a program of research where we identified basic enabling requirements for platforms, created competing platforms that satisfied these requirements, and then evaluated the pedagogical value of the activities that emerged from these platforms.

1.1 Requirements

On the basis of a review of the CSCL literature, we identified the following technical requirements for a platform for implementing collaborative learning activities:

- It must have *latecomer tolerance,* so that devices that join a session after it has started can fully and gracefully catch up without having lost data.
- It must be *robust across dropped connections*, which will occur frequently (although the main concern is not guaranteed transmission with a return receipt, but rather smooth participation in the flow of an activity).

- It must also *support disconnected mode gracefully*, allowing students to work offline and later submit their work in bulk (while catching up as well).
- The coordination layer must have a simple *discovery paradigm* for figuring out what kinds of sessions are running and which ones a user might join.

We created two platforms that satisfied these basic requirements: an "API" platform based on the tuple spaces architecture, and a "GUI" platform, which provided a general-purpose GUI (Graphical User Interface) for activity design.

1.2 Evaluation Criteria

CSCL literature also led us to a list of high-value pedagogical qualities for comparing collaborative learning activities resulting from our platforms:

- *Positive interdependence and individual accountability.* Every student should be individually accountable for some portion of the task, and the overall goal requires all students' contributions (Johnson & Johnson, 1989).
- *Role specialization.* Students should be encouraged to focus deeply on one dimension of teamwork at a time (Kagan, 1992).
- *Even-odd tolerance.* In realistic classroom settings, applications also must address the possibility that "extra" students will be assigned to a group.
- *Support for differential rates of completion.* Some students work faster than others and can be disruptive if they have nothing to do but wait.

A common theme in all the above qualities is the notion of *distributed control* in collaborative learning activities. Interdependence and accountability suggest that students ought

to be making decisions that affect the progression of the activity. Role specialization emphasizes a distribution of responsibilities. Even-odd tolerance is often characterized by the ability of participants themselves to adjust to nonideal student counts, without centralized intervention, say, by the instructor. Finally, support for differential rates is often predicated on the ability of individuals to set the pace of their involvement in an activity.

In particular, we sought to measure the degree to which each platform *inspired* the above qualities. This analysis is distinct from the question of whether a platform simply *enabled* a programmer to create an activity with such qualities.

2. Test Cases

To evaluate the pedagogical value of artifacts derived from our two platforms, we needed test cases in the form of classes of activities to implement. Prior work (DiGiano, Yarnall, Patton, Roschelle, Tatar, et al., 2003) has promoted the value of identifying "whole activity" patterns in collaborative learning activities and using these patterns as objects to think with during design. We started by identifying 41 candidate whole activity patterns to serve as test cases. We then ranked the candidates based on criteria such as importance to science and mathematics education (the content focus of our efforts) and popularity among instructors and the CSCL research community. The top four activity patterns, described below, became the focus of our testing.

1. *Question Posing*. Students propose questions for consideration relative to some topic, and all students are involved in reviewing, ranking, and clustering candidate questions. The result is a ranked set of important questions, with related items gathered in clusters.
2. *Multiple Representations*. A collection of artifacts representing learning phenomena is divided up among students. Each student (or small group of students) is charged with creating one of the preset representation types for the selected artifact.

3. *Simultaneous Annotation*. Students mark up the same content at the same time and then compare and contrast results.
4. *Image Mapping.* The instructor poses an inquiry. Students respond by placing tokens on an image. The instructor and students can then view and discuss the aggregation of tokens.

3. The Tuples API Platform

A common strategy for supporting the implementation of educational software is to add a pedagogically oriented layer to the generic application programming interface (API). This layer can add utilities for managing a collection of activities, persistence of student data, and graphical interface components specifically designed to support student inquiry. The layer can also be useful for ensuring a consistent user experience across a family of related products. We call this approach an "API" platform because educational activities are built on top of this layer by programmers who have learned to leverage the added layer to rapidly construct high-quality artifacts.

To evaluate how best to support the implementation of collaborative learning activities, one of our two platforms took this familiar API approach. As shown in Figure 1, the lowest layer of this platform is the Java programming language. On top of this is a "tuple space" library from IBM for coordinating distributed processes and the Eclipse Project's SWT GUI library (http://eclipse.org). On top of that we wrote abstract classes to simplify the most common tuple space operations and an activity management API, which provides, among other things, a simple interface for participants to select from a list of available activities. Activities implemented on this platform involve a server machine communicating with a network of Java-capable laptop or desktop student devices.

<table>
<tr><td>Abstract Tuple Classes</td><td>Activity Management API</td><td></td></tr>
<tr><td colspan="2">Tuple Space Library (IBM TSpaces)</td><td>GUI Library (Eclipse SWT)</td></tr>
<tr><td colspan="3">Java</td></tr>
</table>

Figure 1. Layers of the API platform for implementing collaborative learning activities.

To appreciate the implementation issues that confront a programmer using this API platform to make a collaborative learning activity, it is important to understand the tuple spaces architecture. Tuple spaces were the conceptual base for the programming language Linda, a language for coordinating parallel processes. The tuple spaces architecture is an example of the "Blackboard Model" of computing, in which there is one central, public data store: the Blackboard. Processes in the system observe this data store independently, watching for data that they can act on, performing actions, and updating the Blackboard accordingly. Coordination in such a system is not determined by a central mediator dictating when the various processes should act; rather, the processes themselves make the determination, and the coordination is emergent. This highly asynchronous model satisfied our technical requirements for robustness across dropped connections and graceful support of disconnected mode. Latecomer tolerance may also be realized insofar as the Blackboard serves as a cache of activity.

The tuple spaces architecture extends the Blackboard metaphor with a specific data structure, the *tuple*; a shared memory structure, *spaces*; and an associated set of operations. *Tuples* are ordered sets of *fields*. *Fields* are data elements that have a value and, depending on implementation, may also have types and/or names. *Spaces* are simply "bags"—sets that can contain duplicate elements—that contain tuples. Three core operations can be performed on a space: *write*, *read*, and *take*. *Write* puts a tuple into a space, *read* reads the value of a tuple in a

space, and *take* removes a tuple from a space. Rather than using a query language to find tuples for read and write operations, the tuple spaces architecture relies on pattern matching for retrieval. A “template” tuple is provided as an argument in read and write operations, and tuples matching that template are returned. This highly flexible data structure and simple query mechanism are relatively easy to learn, compared with alternatives such as database tables and the Structured Query Language.

3.1 Experience with the API Platform

Project team members were able to create instantiations of all four of our test case whole activity patterns in-house:

- *Question Posing*. This involved writing a custom GUI for capturing questions, writing the questions to a tuple space, and ranking them. A specialization of the platform’s abstract tuple class was created to store questions. We used tuple space read operations to collect all questions on a particular topic. This occupied a programmer’s time for several weeks.
- *Multiple Representations*. The existing ChemSense drawing tool from SRI (http://chemsense.org) was repurposed with minimal effort to read and write diagrams from and to a specialization of the abstract tuple class. We also needed to write a specialized GUI widget for writing and taking names of molecules in a tuple space. Identifying which molecules had what representations required invoking the read operation on the space. Two programmers worked together over several weeks.
- *Simultaneous Annotation*. Students mark relevant lines in a document and share their marks. This involved creating a custom document viewer with a check box beside each line of text. A student’s particular subset of selected lines were stored in a specialization of the abstract tuple class. Aggregating student selections required read operations on the

appropriate tuple space. Additional GUI code for browsing and viewing the aggregated selections was created. A bar graph to the right of each line indicates the number of students who highlighted the particular line, and the font size of more popular lines is also increased to indicate frequency of selection. One programmer worked over several weeks.

- *Image Mapping.* We created a custom GUI that could display an arbitrary image file and interpret clicks as token placements. We needed to create a specialization of the abstract tuple class to capture a student's token positions. Token placement involved simply writing this tuple to a particular tuple space. Aggregating tokens involved a tuple space read operation that matched on a particular question posed by the instructor. The GUI required further work to display aggregated tokens with or without attribution. One programmer worked over several weeks.

At least two high-value pedagogical qualities appear in three of these four activities (Table 1). Most support positive interdependence and individual accountability; role specialization was not explored.

Table 1.

Evaluation of Activities Generated by In-House Programmers Using the API and GUI Platforms

Activity pattern	Positive interdependence and individual accountability	Role specialization	Even-odd tolerance	Support for differential rates of completion
Question Posing	API & GUI: Students		API & GUI: Not	API & GUI: Faster

	accountable for creating their own questions; ranking depends on peer contributions		affected by student count	students can always add more questions while waiting for slower ones
Multiple Representations	API: Students accountable for selecting molecules GUI: Students accountable for selecting equations API & GUI: Task completion depends on aggregation of everyone's representations	API & GUI: Certain students can be responsible for particular representation types	API & GUI: If student count is not evenly divisible by representation count, it's OK if a few do an extra round	API & GUI: Faster students can render more representations while waiting for slower ones
Simultaneous Annotation	API: Students contribute to an annotation tapestry GUI: Students contribute to an overall class rating for items (based on number of stars)		API & GUI: Not affected by student count	API: Faster students can do a closer review in a follow-up pass while waiting for slower ones
Image Mapping	API: Students		API & GUI: Not	API & GUI: Faster

	contribute to an emergent pattern of token placements GUI: Students contribute to an emergent class consensus on *Homo sapiens* origin		affected by student count	students likely to influence token placement by slower students

In addition to implementing activities ourselves, we invited college-level student programmers to create collaborative learning activities using the programmer-centric platform. This was done in the context of a 3-week summer workshop at SRI and in one design course during the school year at Virginia Tech. Through direct feedback from students and comments from instructors, we learned that in the first year of instruction these students had considerable difficulty implementing new activities. Some of these difficulties were technical; however, more profoundly, the students had difficulty envisioning the desired activity and the relationships among the activity, the pedagogy, and the design of the system. By arriving at the metaphor of playground games for the activities, the professor was able to convey the relevant values to the students, who in short order successfully built seven working prototypes. As important as that development work was, it became clear that this approach to programming would not lead to spontaneous, self-motivated, untrammeled development (Lin et al., 2006).

3.2 Reflections on the API Platform

We found that applications, such as ChemSense, that were already implemented on other architectures with limited collaborative functionality could be quickly reimplemented by in-

house programmers and “collaboratized” in the tuple spaces framework. For these programmers, our platform provided a powerful and comparatively simple path to adding collaborative functionality to existing, well-understood, applications.

Results suggest that students needed more than simply an improved API. In particular, success was achieved only after significant in-class discussion, debate, and coaching around the nature, possibility, and desirability of highly distributed control.

4. The Group Scribbles GUI Platform

In contrast to the first platform, which was intended for programmers as implementers of collaborative activities, our second platform, “Group Scribbles GUI,” is intended to be used by instructors or non-technical curriculum developers. As illustrated in Figure 2, the GUI platform shares the same foundation of Java and tuples as the API platform. However, the GUI platform adds the Group Scribbles layer, a general-purpose graphical interface for the implementation and execution of collaborative learning activities. It also makes the the lower-level SWT GUI library is inaccessible to activity implementers. Group Scribbles-based activities involve a server machine communicating with a network of student devices, ideally Tablet PCs with a stylus interface (although we also support Pocket PC handhelds and mouse-based laptops or desktops).

Group Scribbles offers implementers, instructors and students what we believe is a powerful metaphor for thinking about and realizing collaborative learning activities. This metaphor is based on common physical artifacts from the classroom or office: adhesive notes, bulletin boards, whiteboards, stickers, pens, and markers. The fundamental unit of expression in Group Scribbles is the Scribble Sheet, a small square of virtual paper just large enough to express a single thought or concept, whether via a quick sketch or a few words jotted down. Scribble

Sheets can be posted to Public Boards, where many sheets can be arranged to express ensemble ideas, such as groupings, chronologies, or hierarchies.

<table>
<tr><td colspan="3">Group Scribbles GUI</td></tr>
<tr><td>Abstract Tuple Classes</td><td>Activity Management API</td><td></td></tr>
<tr><td colspan="2">Tuple Space Library (IBM TSpaces)</td><td>GUI Library (Eclipse SWT)</td></tr>
<tr><td colspan="3">Java</td></tr>
</table>

Figure 2. Layers of the GUI platform for implementing collaborative learning activities.

To understand how one implements a collaborative learning activity in Group Scribbles, it is important to understand what it is like to participate. As shown in Figure 3, each participant has a Private Board on which to create and arrange Scribble Sheets. A given classroom instance of Group Scribbles will have one or more named Public Boards accessible to all users. A typical client view is subdivided to show the user's Private Board in one region and a Public Board in another.

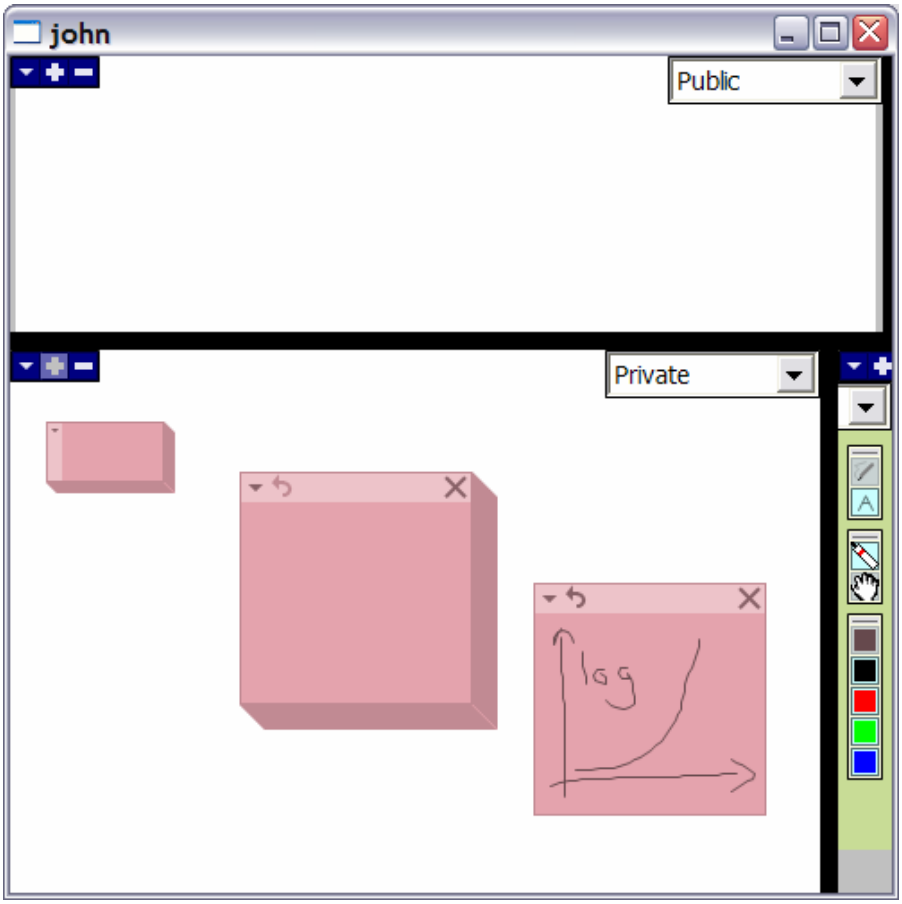

Figure 3. The Group Scribbles GUI with a Private Board below and a Public Board above.

On the Private Board, a user finds a Scribble Pad, an endless source of fresh Scribble Sheets. Users can pull sheets off the pad and write (or type) on them to generate new content. Figure 3 depicts a fully zoomed-in view of the Private Board. Users can zoom out several levels to help arrange and maintain their Scribbles. Also available on the Private Board are Scribble Labels—essentially smaller Scribble Sheets useful for annotation. When users are ready to publish a Scribble Sheet, they simply drag it onto the Public Board. The new sheet then appears on the Public Board of all participants; the frequency of screen updates depends on user configuration.

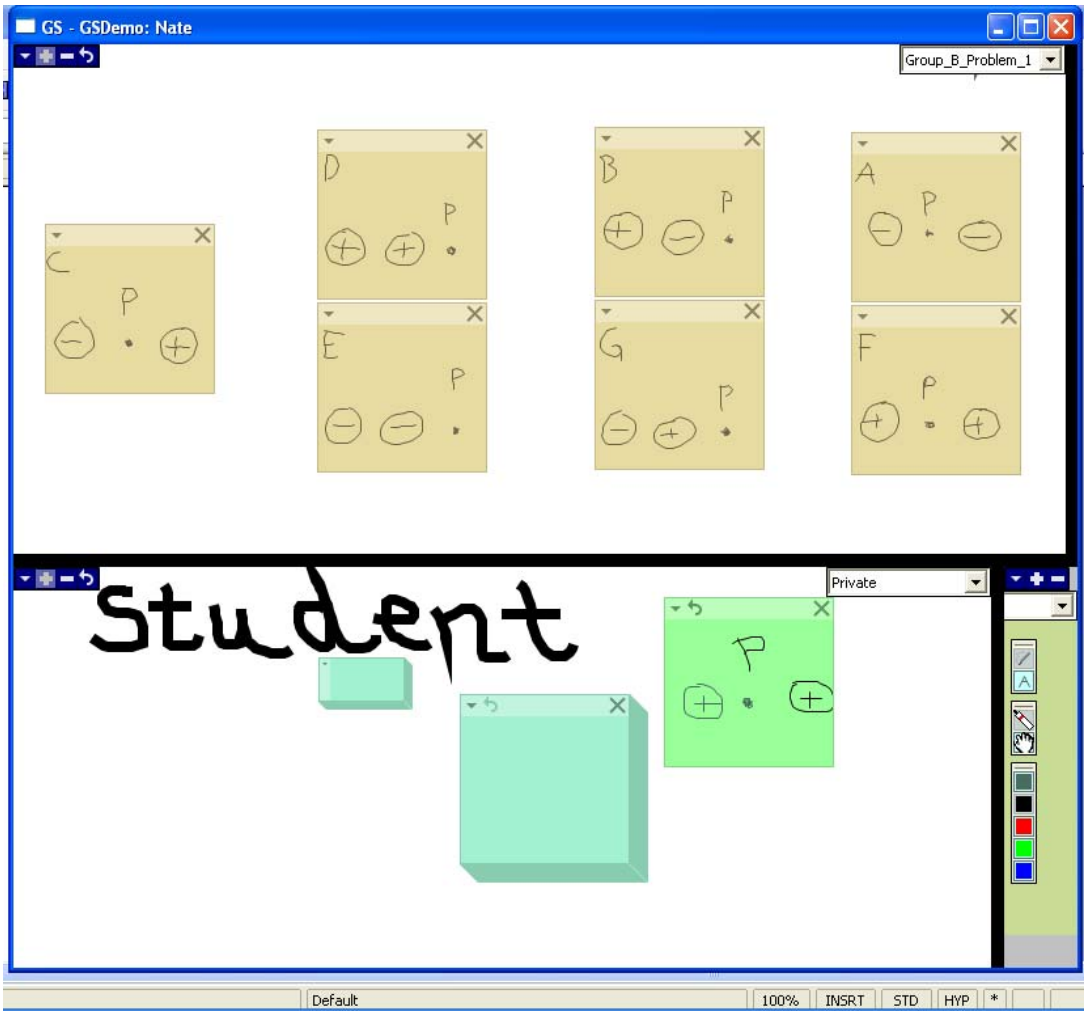

Figure 4. Ranking Task activity with an introductory physics class.

On a Public Board, any user is free to reposition any Scribble Sheet so that, while individual thoughts are expressed within individual sheets, collective ideas are expressed over entire boards. In this way, Scribbles can be sorted, grouped, or otherwise arranged to express interdependent meaning. Scribble Sheets can also be taken from the Public Board (and later returned) and brought onto a user's Private Board (e.g., for activities calling for exchange or to take a token representing a turn in a sequence).

The object of the activity depicted in Figure 4 (Chaudhury et. al., 2002; O'Kuma et. al., 2000) was for students to determine the strength of the electrostatic force at the point P due to seven different arrangements of charges. Students had to solve each scenario, recognize equivalence of certain pairs of scenarios and arrange the sheets from left to right based on the strength of the net force.

Because we built the GUI platform on top of the API platform, it shares all the same technical qualifications of the latter: robustness across dropped connections and graceful support of disconnected mode. Exactly how we implemented Group Scribbles on the API platform is beyond scope of this paper, but it is worth noting that there is a close correspondence between Group Scribbles GUI objects and tuples. For example, when a Scribble Sheet is dropped onto the Public Board, a tuple describing the sheet is written to the tuple spaces server. Other clients with the same Public Board in view will receive notification of the newly written Scribble Sheet tuple. When they read this tuple, the new sheet will be rendered in their view of the Public Board.

The process of implementing a new Group Scribbles activity is not much different from the end-user experience of participating in an activity. It involves placing sheets with seed content on a Public Board and perhaps creating a background image that can contextualize the activity. The board configuration is automatically saved indefinitely under an activity name on the tuple server, so that at any time (a day, a week, or a year later) the instructor can ask students to open the "pre-baked" Group Scribbles GUI through the system's activity manager. The idea that the instructor asks students to perform such a task on their Group Scribbles client is characteristic of activities built on the GUI platform: students are often responsible for pulling content in a distributed fashion because there are no built-in push mechanisms in Group Scribbles (beyond

Public Board sharing). We will show below how this reliance on “social mediation” actually has pedagogical value.

4.1 Experience with the GUI Platform

As detailed below, we were able to create instantiations of all four of our test case whole activity patterns in-house:

- *Question Posing*. The instructor relies on social mediation to get students to scribble a question on a sheet and submit it to the Public Board for review. Students rank questions by jointly arranging sheets on the Public Board, say, from left to right. By default, Group Scribbles with its physical metaphor prevents more than one student from moving a sheet simultaneously. No “pre-baked” content is necessary but an optional background image for the Public Board can suggest bins for organizing questions into groups.
- *Multiple Representations*. We found that a matrix background image (Figure 5) is all that is needed to organize a simple activity in which students render multiple representations of a set of functions, such as an equation, a graph, and a tabular depiction of each. To start the activity, the instructor populates the matrix with a set of tokens. Any student can take a token and replace it with a rendering corresponding to that cell—e.g., a graph of a periodic function.
- *Simultaneous Annotation*. We currently have limited experience with this whole activity pattern. Given the size restrictions of sheets, the classic example of text markup is not easily implemented. However, we have successfully conducted activities in which students use Sheet Labels to attach star ratings to content on the Public Board.
- *Image Mapping.* Again, we found that a background image is all that is needed to implement a simple mapping activity. For example, the instructor loads an image of the

globe onto the background of the Public Board and then uses social mediation to get students to place a Sheet Label on the region associated with the emergence of *Homo sapiens* around 200,000 B.C.

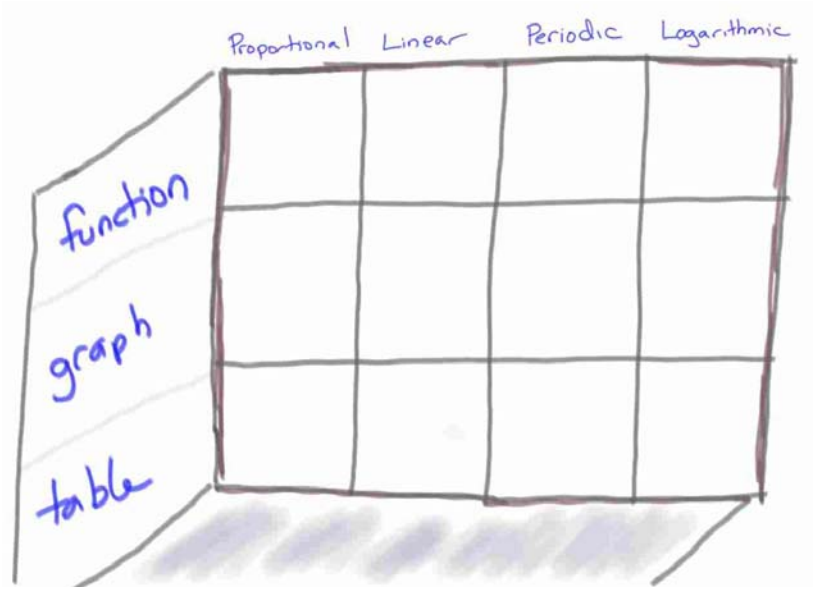

Figure 5. Matrix background image.

To gain more objective feedback on the GUI platform, we tested Group Scribbles in an informal higher education setting—with undergraduate research assistants enrolled in a NASA summer program. Activities were designed for short, 10- to 15-minute interactions, primarily to test the various hardware platforms being investigated for wider classroom use. Question Posing and Image Mapping activities were implemented with a view to whole-class aggregation and discussion. Although no formal assessment of learning based on these sessions was conducted, the students were able to learn to use the basic features of Group Scribbles within a few minutes and successfully participate in instructor-led activities. An emergent feature of the use of the system was back-channel “chats” via Scribble Sheets: even though sheets were being placed on

the Public Board for everyone to see, the content was clearly targeted at specific individuals. In most cases, these individuals had existing social relationships, similar to classic note-passing in secondary classrooms. Formal classroom testing with students enrolled in credit-bearing courses is currently being conducted at a partner university. Preliminary feedback reinforces the view that GS is an easy to learn system and Figure 4. is a direct outcome of a successful learning activity conducted by one of the authors in an introductory physics class for non-science majors.

4.2 Reflections on the GUI Platform

At least two of the desired pedagogical qualities appeared in two of the four activities. As with the API platform, the most prevalent quality was “positive interdependence and individual accountability”; the least prevalent was role specialization.

However, none of the experiences in implementing collaborative learning activities with the GUI platform required programming. With no programmatic control over the design of activity, one might expect that there would be limited opportunity to ensure interactions with high pedagogical value. Yet, our evaluation of the activities showed the presence of almost all the desirable qualities of the much more customized activities built on the API platform. We attribute this success to design features of the Group Scribbles GUI that naturally affords high-quality collaborative activities:

- *(Re)arrangable*. Scribble Sheets can be positioned and repositioned to convey meaning. This feature allows students to jointly negotiate the relationship between artifacts, such as the ranking of questions in the Question Posing activity by simple drag operations. The result is an environment where any student’s response can be subject to challenge, thus emphasizing interdependence.

- *Unique*. As simulated physical artifacts, Scribble Sheets cannot be in more than one place at a time. This attribute naturally supports activities where certain artifacts are manipulated sequentially, such as a particular equation in the function representations activity that gets rendered in one form and then another. Ultimately, this feature simplifies the coordination of artifacts when students are playing specialized roles or trying to avoid duplicate work.
- *Metainformatic*. As described in the simultaneous annotation and image mapping activities, Scribble Sheets and Labels can mark up images or other Scribble Sheets. This feature also contributes to a sense of positive interdependence.
- *Modeless*. Unlike with products of the API platform, our experience is that Group Scribbles (perhaps because of its lack of programmability!) encourages activities in which students are free to choose from a wide variety of operations rather than being constrained to a particular subactivity. The ability for students to be working simultaneously on different aspects of an activity or for one student to use surplus time to revisit an aspect helps support differential rates of completion and even-odd tolerance.

With our GUI platform, the activity implementer sacrifices the possibility of a user experience that is highly tailored to the task at hand. For example, it is not currently feasible to add scaffolding for students to generate valid ball and stick diagrams in chemistry. On the other hand, we have been pleasantly surprised by the wide variety of activities we can support with reasonable fidelity, which we attribute to two other Group Scribbles qualities:

- *Representationally neutral*. Students can use digital ink on Scribble Sheets to easily capture diagrams, drawings, mathematical and scientific notation, and text. Different sizes afford different kinds of activities.

- *Background imagery*. Our experience is that a simple background image, such as of the globe or a Cartesian coordinate system, can provide critical pedagogical context without requiring programming.

Finally, it is worth noting that instructors and students may actually benefit from the fact that Group Scribbles-based activities have a common—albeit somewhat generic—look and feel. Anecdotally, we hear complaints from instructors who must juggle (and subject their students to juggling) many different classroom tools. The flexibility of the Group Scribbles GUI for collaborative learning activities challenges the need for such disparate applications and hints at a future when instructors and students may need to invest in only a small number of core tools that they can grow with over time.

5. Conclusions

Apple's introduction of HyperCard in the 1980s ushered in a wave of inventive and useful educational applications, all created by teachers, students, and other nonprogrammers. Until now, technology-enhanced classroom collaboration and coordination activities have been, like educational applications in pre-HyperCard days, the sole domain of dedicated programming teams, greatly limiting the scope of experimentation and creative effort. Extending the analogy, it may be useful to consider what could be learned from the HyperCard experience that might be applicable to the programmer cognition issue around distributed control: were similar issues neatly sidestepped by HyperCard through appealing directly to end users as programmers? We argue that HyperCard not only provided programming tools to teachers but sidestepped a programmer cognition issue relevant at the time: the conceptual shift to user-event-driven programming.

Though the graphical user interface, and, indeed, hypertext were introduced by SRI researchers in 1968 (Engelbart, 1968), until the time of the introduction of HyperCard, the dominant conception of programming was highly shaped by the terminal interface (DOS command line, telnet, etc.) and an interaction style dominated by computer control in both outputs and inputs ("input statements" are a dead giveaway of this mind-set). In that style, the computer program determines what information is demanded (word used advisedly) of the user and when input is allowed. Programs were normally structured as a branching tree of requests for specific inputs and displays of resulting outputs. The very notion seemed ridiculous that one could create novel and useful applications with only

- buttons to push;
- text fields to type into or click on;
- screens ("cards") containing buttons, graphics, and text fields; and
- the capacity to set up automatic "links" from one card to another (Neuburg, 1994).

But the aspect uniting these elements, and perhaps the most significant payload, was a programming paradigm that situated control primarily in the hands of the user.

Though it is clearly too early to predict with confidence, there is reason to believe that Group Scribbles, with its small set of generic features and emphasis on graphical (and hence machine uninterpretable) content, all united by a distributed control paradigm, could pave the way for a broader understanding of the benefits and challenges of programming in this model.

References

Abrahamson, A. L. (1999). *Teaching with classroom communication system: What it involves and why it works.* Retrieved February 20, 2004, from http://www.bedu.com/Publications/PueblaFinal2.html

DiGiano, C., Yarnall, L., Patton, C., Roschelle, J., Tatar, D., & Manley, M. (2003). Conceptual tools for planning for the wireless classroom. *Journal of Computer Assisted Learning, 19*(3), 284-297.

Chaudhury, S.R., Rodriguez, W.J., Cooper-Pabis, B.J., and Lee, K., "Using Ranking Tasks to Introduce Scientific Visualization in the Lecture", presentation at the AAPT National Meeting, Philadelphia, 2002

Engelbart, D., English, W; "A Research Center for Augmenting Human Intellect," AFIPS Conference Proceedings of the 1968 Fall Joint Computer Conference, San Francisco, CA, December 1968, Vol. 33, pp. 395-410 (AUGMENT,3954,). Johnson, D. W., & Johnson, R. T. (1989). *Cooperation and competition: Theory and research*. Edina, MN: Interaction Book Company.

Kagan, S. (1992). *Cooperative learning.* San Juan Capistrano, CA: Resources for Teachers.

Lin, S., Tatar, D., Harrison, S., Roschelle, J., & Patton, C. (2006, August). *Learning when less is more: "Bootstrapping" undergraduate programmers as coordination designers*. Presented in Exploratory Discussions at the Participatory Design Conference 2006, Trento, Italy.

Neuburg, M. (1994). HyperCard 2.2: The great becomes greater. *TidBITS*, 213. Retrieved from http://db.tidbits.com/article/04075

O'Kuma, T., Maloney, D. and Hieggelke, C., Ranking Task Exercises in Physics, Prentice Hall, 2000

Running head: INFORMAL LEARNING WITH MOBILE DEVICES

Informal Learning Evidence in Online Communities of Mobile Device Enthusiasts

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Abstract

This paper describes a study that investigated the informal learning practices of enthusiastic mobile device owners. Informal learning is far more widespread than is often realised. Livingston (2000) pointed out that Canadian adults spend an average of 15 hours per week on informal learning activities, more than they spend on formal learning activities. The motivation for these learning efforts generally comes from the individual, not from some outside force such as a school, university or workplace. Therefore, in the absence of an externally imposed learning framework, informal learners will use whatever techniques, resources and tools best suit their learning needs and personal preferences. As ownership of mobile technologies becomes increasingly widespread in the western world, it is likely that learners who have access to this technology will use it to support their informal learning efforts. This paper presents the findings of a study into the various and innovative ways in which PDA and Smartphone users exploit mobile device functionality in their informal learning activities.

Vavoula (2004) highlighted some of the difficulties inherent in researching informal learning; it can be intentional or unintentional and people may even be unaware that any learning has taken place. There is also the practical problem of locating a pool of mobile device users who not only engage in mobile informal learning, but who are also willing to provide information about their activities.

PDA and Smartphone enthusiasts were targetted as the community most likely to be using their devices in informal learning and participants were recruited from the active community of web forum users. Web forums are internet-based, asynchronous discussion groups that are aimed at people who share a specific interest; in this case, mobile devices. Messages were posted in the forums inviting members to participate in a web survey on informal learning

with mobile devices. This approach was successful, generating over 200 responses of which over 100 described informal learning with mobile devices.

The findings suggested that mobile device users deploy the mobile, connective and collaborative capabilities of their devices in a variety of informal learning contexts, in quite innovative ways. Trends emerged, such as the increasing importance of podcasting and audio, which may have implications for future studies. Informal learners identified learning activities that could be enhanced by the involvement of mobile technology, and developed methods and techniques that helped them achieve their learning goals.

This paper describes the methods used in the study and discusses the results, locating them in the context of the wider literature on informal learning. It explores key issues, such as participation in collaborative informal learning, that emerged from the findings and outlines research directions arising from the study.

Informal Learning Evidence in online Communities of Mobile Device Enthusiasts

Introduction

According to Tough (1979) an informal learning project is a deliberate effort to gain new knowledge or skills or obtain improved insights or understandings. Livingston (2000) defined informal learning as any activity that involved learning which occurred outside the formal curricula of an educational institution. Livingston went on to make a clear distinction between explicit informal learning, and tacit informal learning which is incorporated into other social or ad-hoc activities. Both forms of learning result in the acquisition of new knowledge or skills, however only the explicit informal learning project is motivated by some immediate problem or need as defined in Tough's (1979) definition of informal learning.

Vavoul, Scanlon, Lonsdale, Sharples, and Jones (2005) developed the classification of informal learning by separating out the goals of learning from the processes of learning as illustrated in Figure 1.

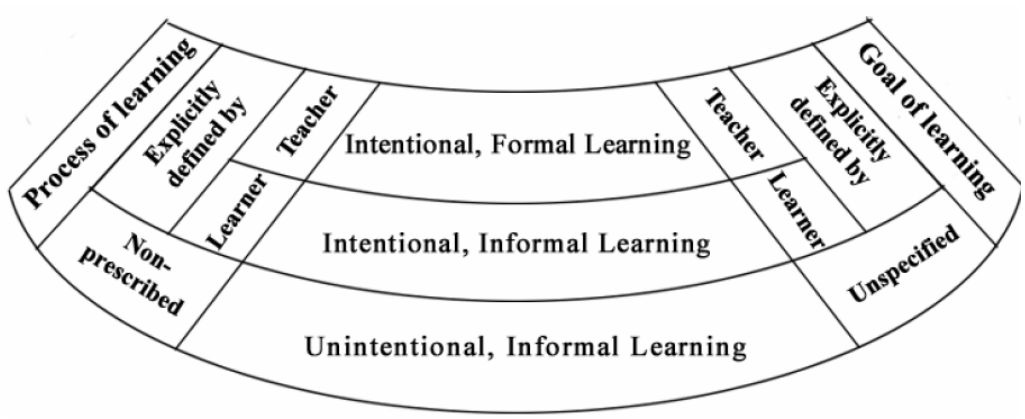

Figure 1. Typology of Informal Learning reproduced from Vavoula et al., (2005)

If both the goals and processes of learning are either explicitly defined by the learner in advance (intentional informal learning) or selected at the point at which the learning opportunity

presents itself (unintentional informal learning), then the tools used to support the learning will also be self-directed. As technology advances, so does the range of potential learning tools.

This paper reports on the results of a study to investigate the informal learning practices of people who owned mobile devices (PDAs or smartphones). Specifically, we asked the question "Do mobile device owners use their devices to support their informal learning projects and if so, how?"

Smartphones are primarily communication devices, and many PDAs now offer several communication protocols such as GPRS and/or wifi. This connectivity supports synchronous communication using voice or instant messaging as well as asynchronous communication via email, weblogs, web forums, wikis and virtual learning environments. In recent years researchers have investigated the potential of mobile handheld devices to support collaborative learning, devising educational scenarios that make use of their collaborative, interactive and mobile capabilities. PDAs have been introduced into schools, both inside the classroom (DiGiano et al., 2003) and outside the classroom in support of fieldwork (Chen, Kao, & Sheu, 2003). Research has also been conducted in the wider learning sphere, with the use of handhelds as interactive museum guidebooks (Hsi, 2003) and as tools to support medical students on hospital placements (Smørdal & Gregory, 2003). Rochelle (2003) identified two forms of collaborative participation; "the normal social participation in classroom discussion (for example) and the new informatic participation among connected devices" (p.262). He discovered that in the classroom setting, where the learners were in the same physical space, the normal face-to-face social interaction was supplemented by the wireless interaction between the connected devices. In this context, mobile devices added a new social dimension of participation that was not otherwise available. Given the growing evidence of support for mobile collaboration in more formal learning

contexts, this study also asked “Do informal learners make use of the connectivity afforded by their mobile devices to engage in collaborative learning?”

Method

In order to obtain insights into ways in which experienced users use mobile devices to support informal learning, this research needed to plug into existing networks and communities of mobile device users. A method was required that would capture information about participants’ informal learning practices and experiences. PDAs and Smartphones are mobile devices and their users may be located anywhere in the world, so a web-based survey method was chosen. This gave access to a wide pool of participants without requiring them to be in any specific geographic location.

Surveys use structured questions to obtain self-reported data from participants. Although surveys are best suited to multiple-choice, quantitative measurements, some of the questions could be adapted to request open-ended, diary-type responses to unearth details of informal learning experiences. By circulating the questionnaire via the Web, additional advantages would accrue. It could be accessed from anywhere in the world, at any time of day, regardless of time-zones and it could be publicised via email and the internet.

In order to identify the preferences and informal learning episodes of experienced mobile device users, we needed a group of users with some level of experience in using their mobile device. Internet-based web forums were selected as the best place in which to find them. There is an active internet-based community of PDA and Smartphone users who participate in a variety of user forums. Membership is free and asynchronous discussion threads allow participants to seek help and discuss a wide variety of device-related issues. Three businesses were also contacted

and agreed to circulate an email to employees with a business PDA or Smartphone, inviting them to participate in the research.

The web survey was published over a period of four weeks in summer. During this time, over 200 responses were returned. When asked whether they used their mobile device to support their informal learning, 53% said that they did and provided details. The questionnaire distinguished between informal learning in general and informal learning for which a mobile device was used in some way. There was no great difference in the occurrence of informal learning between PDA users and Smartphone users. However, PDA users were significantly more likely to use their mobile device in support of their informal learning with 61% of PDA users using their mobile device compared to 31% of Smartphone users ($\chi^2_{(3)} = 19.26$, $p<0.001$) .

The responses were classified using a functional framework devised by Patten, Arnedillo Sanchez, and Tangney (2006). This functional framework was designed as a tool with which to analyse handheld learning applications and evaluate their pedagogical underpinning, however the informal learning activities reported by the survey participants fitted reasonably well.

According to this framework mobile learning applications can be sub-divided into seven categories:

1. **Collaborative applications** that encourage knowledge sharing, making use of the learner's physical location and mobility.
2. **Location aware applications** that contextualise information, allowing learners to interact directly with their environment, for example, collecting environmental data linked to geographical context or accessing contextually relevant reference material

3. **Data collection applications** that use the handheld device's ability to record data in the form of text, image, video and audio
4. **Administrative applications** that employ the typical scheduling, information storage and other calendar functions available on mobile devices
5. **Referential applications** that use dictionaries, translators and e-books to deliver content when and where it is needed
6. **Interactive applications** that use both the input and output capabilities of mobile devices, allowing the learner to input information and obtain some form of feedback which aids the learning process
7. **Microworld applications** model real world domains to enable learners to use practice in a constrained version of the learning scenario. This category was not found in the informal learning results.

Figure 2 groups the informal learning activities described by the survey participants into categories based on the Patten et al., (2006) functional framework.

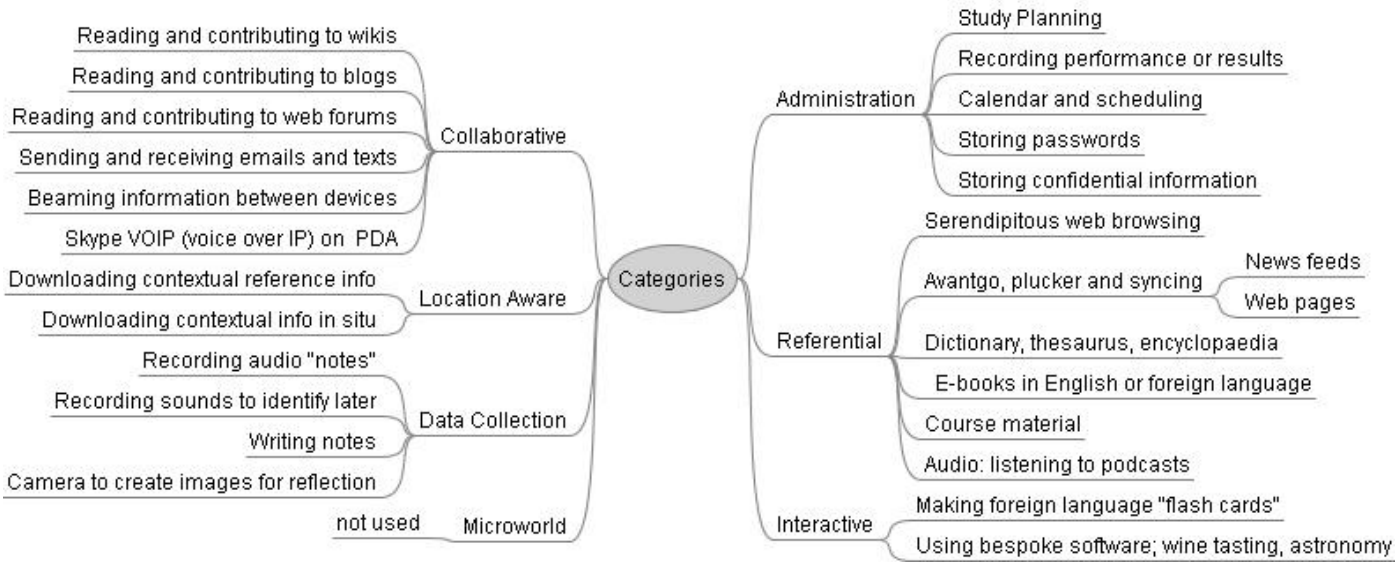

Figure 2. Informal Learning Activities

Collaborative activities

There was a significant difference between PDA and Smartphone users in the level of communication they engaged in using their mobile device, with 100% of Smartphone users using their device to communicate with other compared to 80% of PDA users. Since Smartphones are first and foremost mobile phones, with their high level of connectivity, this result is predictable. Given these fairly high rates of communication using mobile devices, we might expect high levels of collaborative learning.

When asked to provide details of collaborative learning, only 21% of PDA users and 19% of Smartphone users who used their devices to communicate with others felt that they collaborated. However, in their full-text descriptions, some device users demonstrated that they did collaborate; they just did not always recognise it as such. Table 1 lists the main forms that collaborative learning took:

Collaborative resource	**How it is used**
Blog or Weblog	A form of online diary that is easy to create and maintain, and which can be set to allow updates from more than one person. Some participants cited “downloading blogs” as a collaborative activity
Wiki	A group website, similar to a collective blog, where members can create collaborative web pages, updatable by more than one individual and contribute to discussion threads.
Web forum	Websites relating to a particular theme that are maintained by a group of administrators, but which have information threads that can be created and added to by members.

Beaming and sharing information	Sharing data between mobile devices using infra red "beam". Contributing information to a shared database, or one-to-to-one information sharing.

Table 1. Forms of Collaborative Activities

The collaborative activities described generally occurred through the sharing of data in some way, usually by uploading it onto a central server hosting a web forum, wiki or blog. For example, "Collaborating photos and notes to a central server i,e a wiki of sorts"

Web forum users collaborated in many areas, helping each other solve technical problems by posting and answering questions in the forums, building collaborative data bases of information through wiki entries, however in many cases this collaboration took place via the desktop interface rather than that of the mobile device. At the time of the study (summer 2005) internet connectivity using mobile devices was still expensive and the interface clumsy.

Location Aware Activities

Patten et al., (2006) looked at location aware learning applications which use Global Positioning Systems (GPS) and sensors to identify geographical context and promote learner engagement. In 2005 when the survey was conducted, GPS-enabled PDAs were just arriving on the market and the survey participants were beginning to use GPS in their learning. However, the informal learning reported seemed to involve learning how to use GPS applications rather than using the locational awareness to create some form of mobile learning context within the activity.

Data Collection Activities

In the context of this functional framework, data collection refers to the use of mobile devices for recording data and information about the environment. This data may be recorded for reflective purposes, such as taking notes or pictures, or it may consist of observational data that is combined with the observations of others to produce an information database which may provide further learning opportunities. The survey participants did not report collecting observational data, however they did describe recording audio, notes and images.

Audio Data Collection

The audio recording facilities of mobile devices were used by some participants either as an alternative to writing notes on the device, or as a way of recording ambient sounds. For example. One participant reported: "I use my voice recorder to record magic lectures. I also use the memo application for taking notes at magic lectures, taking down important information such as Originators of magical effects, funny lines to remember, names of books, and various sleights to learn".

Taking Notes

Note taking was cited frequently in the context of informal learning. The reasons for taking notes were varied and included:

- Noting down thoughts and ideas to follow up later
- Making notes whilst learning (languages, hobbies)
- Annotating downloaded material
- Writing lists (topics to research, books to read, events to attend)
- Scanning in handwritten notes to have mobile access to them

The voice recording facility was sometimes used to take notes, and mobility was frequently cited as an advantage of taking notes using the mobile device, for example, “Making notes, keeping information with me so I can revise it often”. This activity mirrors the typical handwritten note-taking that most learners engage in. The advantages of using a mobile device (small size, portability, digital notes format that is easily shared with other devices) appear to outweigh any disadvantages of small screen size, slower data entry and reliance on battery.

Recording Images

The cameras on mobile devices were not used to a great extent. At the time of the research, many mobile devices did not contain an in-built camera. Two participants mentioned taking pictures to use for reference later, others mentioned sharing pictures with other people, but images did not appear to be used extensively in informal learning with mobile devices. This may be due to the lower quality of mobile device pictures compared to those from even quite inexpensive digital cameras. It is also possible that images would be used more often if better software were available to integrate them with the learning project.

Looking up Information for Referential Learning Activities

Many participants accessed the web to support their informal learning projects. Some used the PC and transferred the content to the PDA or Smartphone for use when away from the PC. Others accessed the web content directly from their devices using GPRS or wi-fi whenever something sparked their interest, for example one participant wrote “I do a lot of informal learning through wikipedia.org (and that includes using it on my smartphone). I may be thinking about a subject and then I can quickly get out my phone and look the subject matter up on the internet”

Podcasting is a method of audio delivery with implications for teaching and learning. Audio broadcasts are published via the Internet, and users subscribe to a “feed” which allows them to download broadcasts in a format that will run on most handheld devices. Two respondents cited listening to podcasts as a form of informal learning that they did with their device. Audio books were also mentioned as a support for mobile informal learning.

Many participants used specific applications to locate and download text-based information; tools such as Avantgo, Plucker and News feeds were frequently mentioned. AvantGo allows users to register and select from a variety of information services. Information services include newspapers, weather reports, maps, traffic reports, medical details, foreign language and English dictionaries. Having subscribed to the services, the latest news, weather etc gets downloaded to the mobile device automatically when it is synchronised with a PC or laptop. Information obtained in this way varied from reference material such as topic specific web sites and wikipedia (a collaborative web-based encyclopedia that is freely available) to up-to-date news.

Many of the learning activities were built around the ability to read the information using the handheld device whilst in some transitory location, i.e. not home, school or office where other information resources are readily available. Learners tended to identify a period of time when their usual information sources were unavailable, often when in transit, and load information onto their mobile device in advance. Learners would download Ebooks, course material, web pages or papers.

These examples illustrate one of the key advantages of mobile devices; their portability and ability to store large amounts of information in a relatively small package.

Some participants described another approach to using the Web. Rather than downloading information that they could read anywhere, anytime, they downloaded information related to a particular place and event. Information could be researched in advance, for example, downloading maps and tourist information before a planned visit. This usage of a mobile device to store reference material for use when visiting places of interest parallels formal research scenarios such as the electronically guided museum visits described by Hsi (2003).

Administrative Activities

PDAs have their origins as organisational devices and Smartphones have inherited this functionality with 84% of survey participants using the Calendar/Contacts functionality on a daily basis.

Interactive Activities

Where software that would support their learning was available, informal learners made use of it. Applications included wine tasting and charting software, applications for tracking diet and fitness and astronomical charting software. Where the software was not available, some learners were prepared to adapt existing applications, or produce new applications themselves. One participant devised an ingenious way to combine the notes application and the voice-recording in order to support his language learning. He first wrote the question on the note or "front side of the flashcard". Then he made an audio recording which he associated with the note as the "back side of the flashcard". The link to the recording was right next to the text so that he could read the text, say his answer and then check it against the voice-recorded correct answer. Another participant wrote an onboard compiler as well as most of his applications directly on his device, as a hobby which he described as "a never ending learning process in programming knowledge". His ultimate informal learning goal was to write a compiler.

Many mobile device users do not have this level of expertise, but it seems that acquiring a mobile device can trigger device-related learning.

Microworld Applications

Microworlds did not seem to be a category well suited to informal learning since it required the creation of an application that models a real-world domain. No informal learning that would fit into this category was described.

Conclusion

The results of this study suggest that this population of mobile device users use their devices to support a wide range of informal learning activities, both intentional and unintentioal. The portability, storage capacity, computing power and convenience of mobile devices emerged as determining factors in learners' decisions to use them to support informal learning activities. The fact that people generally carried their devices around with them meant that they were "on hand" to support serendipitous learning opportunities as well as planned mobile learning activities.

The Patten et al., (2006) functional framework was helpful in classifying the responses, however some branches of the framework were difficult to map onto the reported informal learning activities, and some of the activities seemed to fit in more than one branch of the framework. Collaboration emerged as a key theme, although one that was relatively unrecognised as such by the participants. The functional framework describes collaborative applications as those that encourage knowledge sharing. However, some of the data collection, referential and location aware activities described by the informal learners also involved knowledge sharing. This meant that there was some overlap between the categories, with certain learning activities having both an "individual" and a "collaborative" element.

The decision to survey expert mobile device users bypassed many of the device usability issues that characterised previous studies (Waycott, 2004), (Smørdal & Gregory, 2003), (Commarford, 2004). For example, the survey participants did not use any one method of data entry (thumbpad, soft keypad, letter recognition, external keyboard) in preference to the others. Instead, participants adapted to the data entry method that worked best for them, with 64% of respondents reporting that they found it "quite easy" or "very easy" on a five-point Likert scale to enter data into their device. When asked how easy they found it to read from the screen, 95% responded "quite easy" or "very easy". Participants adapted to the mobile interface, and evolved ways to integrate the power, storage and connectivity offered by their PDAs and smartphones with their informal learning processes.

A more surprising finding was the extent to which some participants adapted their devices to suit their learning needs, writing new applications or tailoring existing ones, and adapted how they learned to suit the functionality available with their devices. These adaptations seem to be a step beyond the simple process of appropriation of PDAs as workplace and learning tools as described by Waycott, (2004). Waycott defined appropriation as the integration of a new technology into the user's activities. Her analysis showed that there is a two way process in which users adapt the tools they use according to their every day practice, prior expectations and personal preferences in order to carry out their activities and, in turn the tools also change the user's activities. For example, in Waycott's studies participants who were touch-typists coped with the usability constraints of the PDA by using it with a foldout keyboard or as an adjunct to their desktop computer. This adaptation made it easier for them to enter text into the PDA and enabled them to 'fit' the use of the PDA into their every-day preferred practice. In this study some participants went to great lengths to tailor their use of their mobile device to fulfil their

learning goals. The participant who combined text and audio to support his language learning invested a considerable amount of time and effort in adapting the notes application to support his language learning needs. The participants who downloaded material in advance of planned visits had taken the explicit decision to use their mobile device as a learning resource in a mobile context.

This enthusiasm for using mobile devices came across in many of the text responses. The following example is typical of both the content and the length of many of the descriptions of informal learning with mobile devices: “Researching further about geography or science topics I've read about at online sites (Amazon Bore surfing; parasitic creatures). Learning about obscure and/or specific details and terms such as the exact term for a castrated male ‘cow’ (bullock)... could be classified as ‘research related to settling a bet’! Learning new language uses such as urban slang, web chat acronyms, etc. Learning about technology (pdastreet.com forums, MS Windows program shortcuts and how-tos, etc.).” However it is important to remember that the participants in this survey were selected because they were keen mobile device users. This finding may not be reflected in the mobile device using population in general, although as mobile connected technology becomes ubiquitous, it is likely that increasing numbers of mobile device owners will employ their devices as learning tools.

References

Chen, Y. S., Kao, T. C., & Sheu, J. P. (2003). A Mobile Learning System for Scaffolding Bird Watching Learning. *Journal of Computer Assisted Learning, 19*(3), 347-359.

Commarford, P. M. (2004). An Investigation of Text Throughput Speeds Associated with Pocket PC Input Method Editors. *International Journal of Human-computer Interaction, 17*(3), 293-309.

DiGiano, C., Yarnall, L., Patton, C., Roschelle, J., Tatar, D., & Manley, M. (2003). Conceptual Tools for Planning for the Wireless Classroom. *Journal of Computer Assisted Learning, 19*(3), 284-297.

Hsi, H. (2003). A Study of User Experiences Mediated by Nomadic Web Content in a Museum. *Journal of Computer Assisted Learning, 19*(3), 308-319.

Livingston, D. (2000). *Exploring the Icebergs of Adult Learning: Findings of the first Canadian Survey of Informal Learning Practices*. Retrieved November 10, 2006, from http://tortoise.oise.utoronto.ca/~dlivingstone/icebergs/

Patten, B., Arnedillo Sanchez, I., & Tangney, B. (2006). Designing collaborative, constructionist and contextual applications for handheld devices. *Computers & Education, 46*(3), 294-308.

Roschelle. (2003). Unlocking the Learning Value of Wireless Mobile Devices. *Journal of Computer Assisted Learning, 12*(3), 260-272.

Smørdal, O., & Gregory, J. (2003). Personal Digital Assistants in Medical Education and Practice. *Journal of Computer Assisted Learning, 19*, 320-329.

Tough, A. (1979). *The Adult's Learning Projects* (2nd ed.). Ontario: Ontario Institute for Studies in Education.

Vavoula, G. (2004). *KLeOS: A Knowledge and Learning Organisation System in Support of Lifelong Learning.* Unpublished PhD Thesis, University of Birmingham, Birmingham.

Vavoula, G., Scanlon, E., Lonsdale, P., Sharples, M., & Jones, A. (2005). *Report on empirical work with mobile learning and literature on mobile learning in science* (No. D33.2).

Waycott, J. (2004). *The appropriation of PDAs as Learning and Workplace Tools: An Activity theory Perspective.* Unpublished PhD Thesis, Open University, Milton Keynes.

Table 1

Forms of Collaborative Activities

Figure Captions

Figure 1. Typology of Informal Learning (reproduced from Vavoula et al., 2005)

Figure 2. Informal Learning Activities

Running head: INFORMAL LEARNING WITH MOBILE DEVICES

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Informal Learning Evidence in online Communities of Mobile Device Enthusiasts

Introduction

According to Tough (1979) an informal learning project is a deliberate effort to gain new knowledge or skills or obtain improved insights or understandings. Livingston (2000) defined informal learning as any activity that involved learning which occurred outside the formal curricula of an educational institution. Livingston went on to make a clear distinction between explicit informal learning, and tacit informal learning which is incorporated into other social or ad-hoc activities. Both forms of learning result in the acquisition of new knowledge or skills, however only the explicit informal learning project is motivated by some immediate problem or need as defined in Tough's (1979) definition of informal learning.

Vavoul, Scanlon, Lonsdale, Sharples, and Jones (2005) developed the classification of informal learning by separating out the goals of learning from the processes of learning as illustrated in Figure 1.

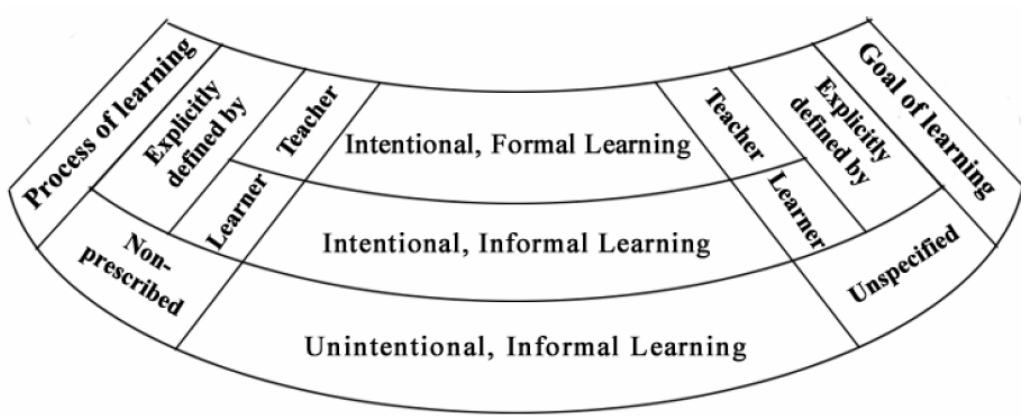

Figure 1. Typology of Informal Learning reproduced from Vavoula et al., (2005)

If both the goals and processes of learning are either explicitly defined by the learner in advance (intentional informal learning) or selected at the point at which the learning opportunity

presents itself (unintentional informal learning), then the tools used to support the learning will also be self-directed. As technology advances, so does the range of potential learning tools.

This paper reports on the results of a study to investigate the informal learning practices of people who owned mobile devices (PDAs or smartphones). Specifically, we asked the question "Do mobile device owners use their devices to support their informal learning projects and if so, how?"

Smartphones are primarily communication devices, and many PDAs now offer several communication protocols such as GPRS and/or wifi. This connectivity supports synchronous communication using voice or instant messaging as well as asynchronous communication via email, weblogs, web forums, wikis and virtual learning environments. In recent years researchers have investigated the potential of mobile handheld devices to support collaborative learning, devising educational scenarios that make use of their collaborative, interactive and mobile capabilities. PDAs have been introduced into schools, both inside the classroom (DiGiano et al., 2003) and outside the classroom in support of fieldwork (Chen, Kao, & Sheu, 2003). Research has also been conducted in the wider learning sphere, with the use of handhelds as interactive museum guidebooks (Hsi, 2003) and as tools to support medical students on hospital placements (Smørdal & Gregory, 2003). Rochelle (2003) identified two forms of collaborative participation; "the normal social participation in classroom discussion (for example) and the new informatic participation among connected devices" (p.262). He discovered that in the classroom setting, where the learners were in the same physical space, the normal face-to-face social interaction was supplemented by the wireless interaction between the connected devices. In this context, mobile devices added a new social dimension of participation that was not otherwise available. Given the growing evidence of support for mobile collaboration in more formal learning

contexts, this study also asked “Do informal learners make use of the connectivity afforded by their mobile devices to engage in collaborative learning?”

Method

In order to obtain insights into ways in which experienced users use mobile devices to support informal learning, this research needed to plug into existing networks and communities of mobile device users. A method was required that would capture information about participants’ informal learning practices and experiences. PDAs and Smartphones are mobile devices and their users may be located anywhere in the world, so a web-based survey method was chosen. This gave access to a wide pool of participants without requiring them to be in any specific geographic location.

Surveys use structured questions to obtain self-reported data from participants. Although surveys are best suited to multiple-choice, quantitative measurements, some of the questions could be adapted to request open-ended, diary-type responses to unearth details of informal learning experiences. By circulating the questionnaire via the Web, additional advantages would accrue. It could be accessed from anywhere in the world, at any time of day, regardless of time-zones and it could be publicised via email and the internet.

In order to identify the preferences and informal learning episodes of experienced mobile device users, we needed a group of users with some level of experience in using their mobile device. Internet-based web forums were selected as the best place in which to find them. There is an active internet-based community of PDA and Smartphone users who participate in a variety of user forums. Membership is free and asynchronous discussion threads allow participants to seek help and discuss a wide variety of device-related issues. Three businesses were also contacted

and agreed to circulate an email to employees with a business PDA or Smartphone, inviting them to participate in the research.

The web survey was published over a period of four weeks in summer. During this time, over 200 responses were returned. When asked whether they used their mobile device to support their informal learning, 53% said that they did and provided details. The questionnaire distinguished between informal learning in general and informal learning for which a mobile device was used in some way. There was no great difference in the occurrence of informal learning between PDA users and Smartphone users. However, PDA users were significantly more likely to use their mobile device in support of their informal learning with 61% of PDA users using their mobile device compared to 31% of Smartphone users ($\chi^2_{(3)} = 19.26$, $p<0.001$) .

The responses were classified using a functional framework devised by Patten, Arnedillo Sanchez, and Tangney (2006). This functional framework was designed as a tool with which to analyse handheld learning applications and evaluate their pedagogical underpinning, however the informal learning activities reported by the survey participants fitted reasonably well.

According to this framework mobile learning applications can be sub-divided into seven categories:

1. **Collaborative applications** that encourage knowledge sharing, making use of the learner's physical location and mobility.
2. **Location aware applications** that contextualise information, allowing learners to interact directly with their environment, for example, collecting environmental data linked to geographical context or accessing contextually relevant reference material

3. **Data collection applications** that use the handheld device's ability to record data in the form of text, image, video and audio
4. **Administrative applications** that employ the typical scheduling, information storage and other calendar functions available on mobile devices
5. **Referential applications** that use dictionaries, translators and e-books to deliver content when and where it is needed
6. **Interactive applications** that use both the input and output capabilities of mobile devices, allowing the learner to input information and obtain some form of feedback which aids the learning process
7. **Microworld applications** model real world domains to enable learners to use practice in a constrained version of the learning scenario. This category was not found in the informal learning results.

Figure 2 groups the informal learning activities described by the survey participants into categories based on the Patten et al., (2006) functional framework.

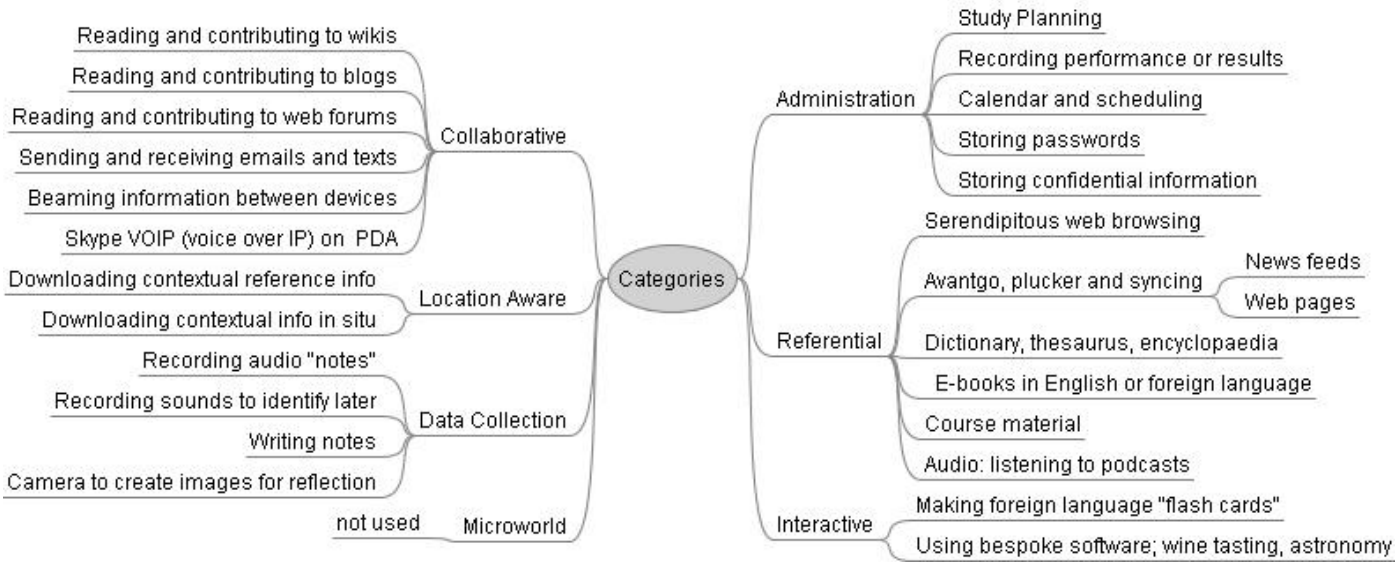

Figure 2. Informal Learning Activities

Collaborative activities

There was a significant difference between PDA and Smartphone users in the level of communication they engaged in using their mobile device, with 100% of Smartphone users using their device to communicate with other compared to 80% of PDA users. Since Smartphones are first and foremost mobile phones, with their high level of connectivity, this result is predictable. Given these fairly high rates of communication using mobile devices, we might expect high levels of collaborative learning.

When asked to provide details of collaborative learning, only 21% of PDA users and 19% of Smartphone users who used their devices to communicate with others felt that they collaborated. However, in their full-text descriptions, some device users demonstrated that they did collaborate; they just did not always recognise it as such. Table 1 lists the main forms that collaborative learning took:

Collaborative resource	**How it is used**
Blog or Weblog	A form of online diary that is easy to create and maintain, and which can be set to allow updates from more than one person. Some participants cited “downloading blogs” as a collaborative activity
Wiki	A group website, similar to a collective blog, where members can create collaborative web pages, updatable by more than one individual and contribute to discussion threads.
Web forum	Websites relating to a particular theme that are maintained by a group of administrators, but which have information threads that can be created and added to by members.

Beaming and sharing information	Sharing data between mobile devices using infra red "beam". Contributing information to a shared database, or one-to-to-one information sharing.

Table 1. Forms of Collaborative Activities

The collaborative activities described generally occurred through the sharing of data in some way, usually by uploading it onto a central server hosting a web forum, wiki or blog. For example, "Collaborating photos and notes to a central server i,e a wiki of sorts"

Web forum users collaborated in many areas, helping each other solve technical problems by posting and answering questions in the forums, building collaborative data bases of information through wiki entries, however in many cases this collaboration took place via the desktop interface rather than that of the mobile device. At the time of the study (summer 2005) internet connectivity using mobile devices was still expensive and the interface clumsy.

Location Aware Activities

Patten et al., (2006) looked at location aware learning applications which use Global Positioning Systems (GPS) and sensors to identify geographical context and promote learner engagement. In 2005 when the survey was conducted, GPS-enabled PDAs were just arriving on the market and the survey participants were beginning to use GPS in their learning. However, the informal learning reported seemed to involve learning how to use GPS applications rather than using the locational awareness to create some form of mobile learning context within the activity.

Data Collection Activities

In the context of this functional framework, data collection refers to the use of mobile devices for recording data and information about the environment. This data may be recorded for reflective purposes, such as taking notes or pictures, or it may consist of observational data that is combined with the observations of others to produce an information database which may provide further learning opportunities. The survey participants did not report collecting observational data, however they did describe recording audio, notes and images.

Audio Data Collection

The audio recording facilities of mobile devices were used by some participants either as an alternative to writing notes on the device, or as a way of recording ambient sounds. For example. One participant reported: "I use my voice recorder to record magic lectures. I also use the memo application for taking notes at magic lectures, taking down important information such as Originators of magical effects, funny lines to remember, names of books, and various sleights to learn".

Taking Notes

Note taking was cited frequently in the context of informal learning. The reasons for taking notes were varied and included:

- Noting down thoughts and ideas to follow up later
- Making notes whilst learning (languages, hobbies)
- Annotating downloaded material
- Writing lists (topics to research, books to read, events to attend)
- Scanning in handwritten notes to have mobile access to them

The voice recording facility was sometimes used to take notes, and mobility was frequently cited as an advantage of taking notes using the mobile device, for example, “Making notes, keeping information with me so I can revise it often”. This activity mirrors the typical handwritten note-taking that most learners engage in. The advantages of using a mobile device (small size, portability, digital notes format that is easily shared with other devices) appear to outweigh any disadvantages of small screen size, slower data entry and reliance on battery.

Recording Images

The cameras on mobile devices were not used to a great extent. At the time of the research, many mobile devices did not contain an in-built camera. Two participants mentioned taking pictures to use for reference later, others mentioned sharing pictures with other people, but images did not appear to be used extensively in informal learning with mobile devices. This may be due to the lower quality of mobile device pictures compared to those from even quite inexpensive digital cameras. It is also possible that images would be used more often if better software were available to integrate them with the learning project.

Looking up Information for Referential Learning Activities

Many participants accessed the web to support their informal learning projects. Some used the PC and transferred the content to the PDA or Smartphone for use when away from the PC. Others accessed the web content directly from their devices using GPRS or wi-fi whenever something sparked their interest, for example one participant wrote “I do a lot of informal learning through wikipedia.org (and that includes using it on my smartphone). I may be thinking about a subject and then I can quickly get out my phone and look the subject matter up on the internet”

Podcasting is a method of audio delivery with implications for teaching and learning. Audio broadcasts are published via the Internet, and users subscribe to a “feed” which allows them to download broadcasts in a format that will run on most handheld devices. Two respondents cited listening to podcasts as a form of informal learning that they did with their device. Audio books were also mentioned as a support for mobile informal learning.

Many participants used specific applications to locate and download text-based information; tools such as Avantgo, Plucker and News feeds were frequently mentioned. AvantGo allows users to register and select from a variety of information services. Information services include newspapers, weather reports, maps, traffic reports, medical details, foreign language and English dictionaries. Having subscribed to the services, the latest news, weather etc gets downloaded to the mobile device automatically when it is synchronised with a PC or laptop. Information obtained in this way varied from reference material such as topic specific web sites and wikipedia (a collaborative web-based encyclopedia that is freely available) to up-to-date news.

Many of the learning activities were built around the ability to read the information using the handheld device whilst in some transitory location, i.e. not home, school or office where other information resources are readily available. Learners tended to identify a period of time when their usual information sources were unavailable, often when in transit, and load information onto their mobile device in advance. Learners would download Ebooks, course material, web pages or papers.

These examples illustrate one of the key advantages of mobile devices; their portability and ability to store large amounts of information in a relatively small package.

Some participants described another approach to using the Web. Rather than downloading information that they could read anywhere, anytime, they downloaded information related to a particular place and event. Information could be researched in advance, for example, downloading maps and tourist information before a planned visit. This usage of a mobile device to store reference material for use when visiting places of interest parallels formal research scenarios such as the electronically guided museum visits described by Hsi (2003).

Administrative Activities

PDAs have their origins as organisational devices and Smartphones have inherited this functionality with 84% of survey participants using the Calendar/Contacts functionality on a daily basis.

Interactive Activities

Where software that would support their learning was available, informal learners made use of it. Applications included wine tasting and charting software, applications for tracking diet and fitness and astronomical charting software. Where the software was not available, some learners were prepared to adapt existing applications, or produce new applications themselves. One participant devised an ingenious way to combine the notes application and the voice-recording in order to support his language learning. He first wrote the question on the note or "front side of the flashcard". Then he made an audio recording which he associated with the note as the "back side of the flashcard". The link to the recording was right next to the text so that he could read the text, say his answer and then check it against the voice-recorded correct answer. Another participant wrote an onboard compiler as well as most of his applications directly on his device, as a hobby which he described as "a never ending learning process in programming knowledge". His ultimate informal learning goal was to write a compiler.

Many mobile device users do not have this level of expertise, but it seems that acquiring a mobile device can trigger device-related learning.

Microworld Applications

Microworlds did not seem to be a category well suited to informal learning since it required the creation of an application that models a real-world domain. No informal learning that would fit into this category was described.

Conclusion

The results of this study suggest that this population of mobile device users use their devices to support a wide range of informal learning activities, both intentional and unintentioal. The portability, storage capacity, computing power and convenience of mobile devices emerged as determining factors in learners' decisions to use them to support informal learning activities. The fact that people generally carried their devices around with them meant that they were "on hand" to support serendipitous learning opportunities as well as planned mobile learning activities.

The Patten et al., (2006) functional framework was helpful in classifying the responses, however some branches of the framework were difficult to map onto the reported informal learning activities, and some of the activities seemed to fit in more than one branch of the framework. Collaboration emerged as a key theme, although one that was relatively unrecognised as such by the participants. The functional framework describes collaborative applications as those that encourage knowledge sharing. However, some of the data collection, referential and location aware activities described by the informal learners also involved knowledge sharing. This meant that there was some overlap between the categories, with certain learning activities having both an "individual" and a "collaborative" element.

The decision to survey expert mobile device users bypassed many of the device usability issues that characterised previous studies (Waycott, 2004), (Smørdal & Gregory, 2003), (Commarford, 2004). For example, the survey participants did not use any one method of data entry (thumbpad, soft keypad, letter recognition, external keyboard) in preference to the others. Instead, participants adapted to the data entry method that worked best for them, with 64% of respondents reporting that they found it "quite easy" or "very easy" on a five-point Likert scale to enter data into their device. When asked how easy they found it to read from the screen, 95% responded "quite easy" or "very easy". Participants adapted to the mobile interface, and evolved ways to integrate the power, storage and connectivity offered by their PDAs and smartphones with their informal learning processes.

A more surprising finding was the extent to which some participants adapted their devices to suit their learning needs, writing new applications or tailoring existing ones, and adapted how they learned to suit the functionality available with their devices. These adaptations seem to be a step beyond the simple process of appropriation of PDAs as workplace and learning tools as described by Waycott, (2004). Waycott defined appropriation as the integration of a new technology into the user's activities. Her analysis showed that there is a two way process in which users adapt the tools they use according to their every day practice, prior expectations and personal preferences in order to carry out their activities and, in turn the tools also change the user's activities. For example, in Waycott's studies participants who were touch-typists coped with the usability constraints of the PDA by using it with a foldout keyboard or as an adjunct to their desktop computer. This adaptation made it easier for them to enter text into the PDA and enabled them to 'fit' the use of the PDA into their every-day preferred practice. In this study some participants went to great lengths to tailor their use of their mobile device to fulfil their

learning goals. The participant who combined text and audio to support his language learning invested a considerable amount of time and effort in adapting the notes application to support his language learning needs. The participants who downloaded material in advance of planned visits had taken the explicit decision to use their mobile device as a learning resource in a mobile context.

This enthusiasm for using mobile devices came across in many of the text responses. The following example is typical of both the content and the length of many of the descriptions of informal learning with mobile devices: “Researching further about geography or science topics I've read about at online sites (Amazon Bore surfing; parasitic creatures). Learning about obscure and/or specific details and terms such as the exact term for a castrated male ‘cow’ (bullock)... could be classified as ‘research related to settling a bet’! Learning new language uses such as urban slang, web chat acronyms, etc. Learning about technology (pdastreet.com forums, MS Windows program shortcuts and how-tos, etc.).” However it is important to remember that the participants in this survey were selected because they were keen mobile device users. This finding may not be reflected in the mobile device using population in general, although as mobile connected technology becomes ubiquitous, it is likely that increasing numbers of mobile device owners will employ their devices as learning tools.

References

Chen, Y. S., Kao, T. C., & Sheu, J. P. (2003). A Mobile Learning System for Scaffolding Bird Watching Learning. *Journal of Computer Assisted Learning, 19*(3), 347-359.

Commarford, P. M. (2004). An Investigation of Text Throughput Speeds Associated with Pocket PC Input Method Editors. *International Journal of Human-computer Interaction, 17*(3), 293-309.

DiGiano, C., Yarnall, L., Patton, C., Roschelle, J., Tatar, D., & Manley, M. (2003). Conceptual Tools for Planning for the Wireless Classroom. *Journal of Computer Assisted Learning, 19*(3), 284-297.

Hsi, H. (2003). A Study of User Experiences Mediated by Nomadic Web Content in a Museum. *Journal of Computer Assisted Learning, 19*(3), 308-319.

Livingston, D. (2000). *Exploring the Icebergs of Adult Learning: Findings of the first Canadian Survey of Informal Learning Practices*. Retrieved November 10, 2006, from http://tortoise.oise.utoronto.ca/~dlivingstone/icebergs/

Patten, B., Arnedillo Sanchez, I., & Tangney, B. (2006). Designing collaborative, constructionist and contextual applications for handheld devices. *Computers & Education, 46*(3), 294-308.

Roschelle. (2003). Unlocking the Learning Value of Wireless Mobile Devices. *Journal of Computer Assisted Learning, 12*(3), 260-272.

Smørdal, O., & Gregory, J. (2003). Personal Digital Assistants in Medical Education and Practice. *Journal of Computer Assisted Learning, 19*, 320-329.

Tough, A. (1979). *The Adult's Learning Projects* (2nd ed.). Ontario: Ontario Institute for Studies in Education.

Vavoula, G. (2004). *KLeOS: A Knowledge and Learning Organisation System in Support of Lifelong Learning.* Unpublished PhD Thesis, University of Birmingham, Birmingham.

Vavoula, G., Scanlon, E., Lonsdale, P., Sharples, M., & Jones, A. (2005). *Report on empirical work with mobile learning and literature on mobile learning in science* (No. D33.2).

Waycott, J. (2004). *The appropriation of PDAs as Learning and Workplace Tools: An Activity theory Perspective.* Unpublished PhD Thesis, Open University, Milton Keynes.

Table 1

Forms of Collaborative Activities

Figure Captions

Figure 1. Typology of Informal Learning (reproduced from Vavoula et al., 2005)

Figure 2. Informal Learning Activities

Introducing Blended mLearning Solutions for Higher Education Students

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Abstract

Our ongoing work at London Metropolitan University investigates effective ways to design learning environments that add mobile learning into blended higher education modules. Our approach is one of evolutionary, iterative refinement of the learning environment based on student feedback. Blended learning effectiveness can be viewed as a function of effective pedagogical practices. Accordingly, a key question is: What combination of instructional strategies and delivery media will best produce the desired learning outcome for the intended audience? The paper will (i) outline the background issues that led to the development of the blended mLearning approach (ii) describe the initial survey that informed our design, (iii) outline the blended mLearning design, (iv) present our evaluation findings with students, and (v) conclude by commenting on the wider applicability of our approach.

Introducing Blended mLearning Solutions for Higher Education Students

Introduction

In his keynote at mLearn 2005, Stan Trollip (Trollip, 2005) exhorted the field of mobile learning to make a difference and not just to have fun. Our ongoing work at London Metropolitan University attempts to make a difference by investigating effective ways to design learning environments that add mobile learning into blended higher education modules. Our approach is one of evolutionary, iterative refinement of the learning environment based on student feedback.

Blended learning effectiveness can be viewed as a function of effective pedagogical practices. Accordingly, a key question is: What combination of instructional strategies and delivery media will best produce the desired learning outcome for the intended audience? Specifically, as the work got under way we took the provisional view that approaches to mobile learning have to take care not to 'invade' the personal mobile devices of learners, e.g. mobile phones, PDAs, iPods, etc. However, we also believed (we still do) that if we conduct, or listen to the research that is asking the right kind of questions, then we increase the chances of developing a blended model of learning that (i) puts pedagogy first, (ii) uses the different media effectively, and (iii) enables students to learn together effectively. Consequently, in our work we took some time to incorporate the student's view into the pedagogical design process.

We introduced mobile technologies, as a pilot project at the UK's Centre for Excellence in Teaching and Learning (CETL) for Reusable Learning Objects (RLOs), or RLO-CETL for short, to first year undergraduate students taking an introductory marketing module. The RLO-CETL (http://www.rlo-cetl.ac.uk/) is being funded by Higher Education Funding Council for England to develop a range of multimedia learning objects that can be stored in repositories, accessed over the Web, and integrated into course delivery. London Metropolitan University is the lead site, in partnership with the Universities of Cambridge and Nottingham.

An earlier project (Holley and Dobson, 2005) provided some tentative evidence which suggested that by assisting students to erode the time and space barriers between their multi-faceted lives, they will start to engage with the learning process. Consequently, the RLO-CETL team took the decision that the potential for 'any time, any places, at my own pace' flexibility that mobile learning is purported to offer would be of real benefit to our students. However, as stated above, we took the provisional view that approaches to mobile learning have to take care not to 'invade' the personal devices of learners and we were adamant that we wanted to put pedagogy first. Consequently, the next section describes an initial survey that intended to build up a profile of our learners so that we would, hopefully, be better able to incorporate the student's view in our learning environment design.

The students in the case study described in this paper visit the UK's Tate Modern art gallery as part of their 'Studying Marketing and Operations' module. This is a taught module that makes use of a blended learning approach. The module has lectures and seminars plus a series of assignments. In one assignment (the focus of this paper), small groups students visit the Tate

Modern art gallery, select a piece of artwork, and develop a product from this that is suitable for sale in the art gallery shop. Previous research on group work in higher education using Tablet PCs (e.g. Kiddie et al., 2004; Corlett & Sharples, 2004) has suggested that such an approach is a productive way forward. Corlett & Sharples (2004) investigated the use of Tablet PCs with 3rd year students from a Masters in Engineering course. They found that tablets afford anytime, anywhere access to productivity, communication and information tools, which meant that learning activities became more productive. Unlike these studies our work starts from gaining an understanding of the mobile devices that the students' own already in an attempt to design a blended learning environment that could potentially accommodate such a learner population profile.

The paper will (i) outline the background problems that led to the development of the blended mLearning approach (ii) describe the initial survey that informed our design, (iii) outline the blended mLearning design (plus preliminary evaluation of the design), (iv) our evaluation findings with students, and (v) conclude by commenting on the wider applicability of our approach.

Student mobile phone survey

The starting point for this work was to conduct a student survey. We assumed that the majority of students would have mobile phones, but we didn't really know this, and we certainly didn't know what phones they were likely to have and what they would be able to use them for. One of the lecturers working with the RLO-CETL suggested that we could give a questionnaire to her first-year students, taking a 'Marketing and Operations' module. The survey was conducted in October 2005. The questionnaire had 10 questions, designed to find out about their mobile phone ownership, and to identify their views on using their mobiles for teaching and learning.

69 students completed the questionnaire. The majority of the students were females (69%), and 60% were between 18 and 21, 25% 21-25, 10% 25-30, 3% 30-35, with 1 student over 35. Only 1 student didn't own a mobile phone (98.6% had mobiles). 73% of students had their own PC at home, and the remainder mainly used PCs at university (15%) or used an Internet café (3%) or a combination of PCs at university and in cafes (9%). From this we can deduce that the students should have relatively good IT skills.

The survey identified the type of mobile phones owned and showed that students possessed a range of different phones. Students owned 9 makes of phone between them (although some weren't sure what they had), with Nokia being the most common (44%). The range of models was also diverse. Most kept a phone for about 12 months (38%), with 36.5% changing them every 18 months, 9.5% every 6 months, and 16% keeping them for as long as possible. So the majority changed their phone quite frequently. To give an indication of how up-to-date their phones were, we asked what features they had (see Table 1). This was also important for us to know potentially what they could do with their phones e.g. take photographs, log onto the Internet. 68% had colour screens, 68% cameras, 56% Internet/WAP, 14% 3G and 41% Bluetooth. Only 1% had wireless (WIFI).

Insert Table 1: Mobile phone features

The survey also asked them if they had contracts with a mobile phone provider or were on ‘pay as you go’. We thought that those having to pay per item may be more reluctant to use their phones because of the costs they would incur. In reality the group was evenly split, with 46% having contracts, and 54% using ‘pay as you go’.

Three questions were asked about their views of using their mobiles for teaching and learning.

Question 1: Is the ability to learn at any time and in any place important to you? 62% of students viewed the ability to learn at any time and in any place as ‘extremely important’ (which is the combined scores for responses 1 and 2 in Table 2). Only 15% viewed this opportunity as ‘not at all important’ (which is the combined scores for responses 4 and 5 in Table 2).

Question 2: How useful would it be to access learning materials via your mobile? As Table 3 shows, 39% thought it would be ‘extremely useful’, whereas 41% said it was ‘not useful at all’.

Question 3: How would you view the university contacting you via your mobile for learning purposes? As Table 4 shows, 55% of the students answered that ‘it would be a positive aspect’. Only 23% thought ‘it would be a negative aspect’.

Insert Table 2: Is the ability to learn at any time and in any place important to you?

Insert Table 3: How useful would it be to access learning materials via your mobile?

Insert Table 4: How would you view the university contacting you via your mobile for learning purposes?

As we pointed out in the Introduction, the desire to learn at any time in any place (question 1) is a much touted positive of mLearning and our results seem to confirm this. Regarding access to learning materials via your phone (question 2) there appears to be some reticence at the moment towards this question with a slight majority in favour. However, this is really only feasible on phones with larger screens, and therefore it is possible that students with older models couldn’t visualise using learning materials on the particular phones they had (32% didn’t have colour screens for example). The result for question 3 came as something of a surprise to us. We had assumed that students would regard their phone as their personal property and would not wish to have their ‘personal space’ invaded by the University for learning purposes.

The results of the survey confirmed our assumptions that nearly all students (98.6%) owned a mobile phone, and therefore that it was feasible to embark on a pilot project which utilised their phones for teaching and learning.

Blended mLearning design

On the basis of the survey results we introduced mobile technologies as an RLO-CETL 'mini-project' into the module that had been used to gather the survey data, a first-year module on Studying Marketing and Operations. The lecturer we were working with was also developing learning objects on study skills with the RLO-CETL to incorporate within the module. This particular module is a core 1st year module taken by all new business and marketing students, and is in essence a 'study skills' module. It is a taught module that makes use of a blended learning approach. The module has lectures and seminars plus a series of assignments. It had recently been re-designed to include an initial assessed assignment that would encourage new students to settle in quickly and facilitate small friendship groups from their first week. It was supported by an online resource that would engage students from their first lecture/seminar and enable them to work independently on something interesting and directly related to their assessment. For this first assignment, in small groups students visit the Tate Modern art gallery, select a piece of artwork, and develop a product from this that is suitable for sale in the art gallery shop. They have to develop a marketing plan, and present this with their product idea as a presentation to the whole group.

In response to the survey results (specifically question 2), we decided against using learning resources over mobile phones, but instead decided to opt for a resource that facilitates teamwork over multiple communication devices, and that could support the first assignment. In previous years, the lecturer had noted that the students had often not visited The Tate together, and that that this resource might help students to get their assignment underway. The Spring Semester intake of students was chosen for the pilot, as a much smaller group of 15-20 students were expected, and could more effectively be supported in using the new mLearning elements of the blend.

A multimedia message board 'mediaBoard' (http://www.mediaBoard.co.uk) was introduced to support communication, teamwork and the exchange of ideas for the students. Students can contribute by sending messages from their mobiles and PDAs or a PC, submitting text, images and audio files via SMS, MMS and emails. mediaBoard was an attractive solution because students could use their own mobiles to contribute to it, but could also use a PC if they didn't have a phone (accommodating the few percentage that don't) or didn't want to use their phone for the exercise.

The overall module blend included a weekly lecture and seminar, a multimedia message board (mediaBoard), supplemented with other web-based learning aids, which included an mLearning learning object on 'how to get going with mediaBoard' and learning objects (LOs) that gave assistance on reflective writing and how to cite and reference books, journals and web sites. We used a team-based, rapid prototyping technique (Cook et al., 2006) to develop our LOs; an example of a LO is shown in Figure 1. We also introduced timely text messages giving 'learning hints' (in response to question 3 of our survey), which included reminders for seminars, course-work deadlines and pointers to online learning resources that could help learners.

Our LOs have not yet been optimised for multimedia mobile learning; however, we intend to do this by drawing on the experience already built up in the team (Bradley and Haynes, 2005). The

brief for the design of the mLearning LO was to deconstruct the different methods of using the mediaBoard for students to communicate with their team and develop their product ideas to complete the assignment. Macromedia Captivate was used to capture the interaction of a user uploading material to the mediaBoard via the four distinct methods (SMS and MMS from mobile phones, email and directly in mediaBoard). The learning tool contained seven simple tutorials with the addition of audio commentary to explain in approximately twenty minutes how to take advantage of all the functionality of the mediaBoard.

Figure 1. Screen shot of learning object ‘How to use mediaBoard’

Before mediaBoard was introduced to the students, we conducted the same mobile phone survey used before in February 2006, to ascertain that sufficient numbers of students had mobiles that would enable them to contribute to mediaBoard using their own phones. 48 students completed this second questionnaire. The student profile was slightly different to the initial questionnaire: there was a more balanced gender split (53% male and 47% female as opposed to 69% female in October), and the students were slightly older. However, the results on the whole were similar. 2 students didn’t own a mobile, but we later found out that one of these students bought one after completing the survey. 50% had contracts with mobile phone providers. 45% of the students were positive about being contacted by the University on their mobile, 33% were not sure, and 22% were negative. On the basis of these results, we decided to go ahead with the pilot.

Three separate mediaBoards were created to adequately support the number of students (the intake for this module was larger than expected). The main interface for a mediaBoard is a graphical image. Zones are then created, in our case one for each team, represented by the red circles on the image in Figure 2. Each team member can click on their team zone and then add comments and resources via the several communication mediums that are possible (email, SMS, MMS, etc). We also created a ‘Help’ zone, where students could post messages if they were encountering problems, which we would reply to. Students were registered in the mediaBoard according to their respective team. Each board had its own password and is not visible to people not registered for it, but team zones were not protected, and therefore visible to all members of the board.

Figure 2: The mediaBoard for teams 1-10 in seminar group 2

mediaBoard was described to the students as a new internet technology which will enable them to create their own interactive message board in order to complete their assignment brief. It was also explained that it achieves this by providing a virtual space, which can be used in ‘real-time’ during the visit to the Tate Modern. It does this by acting as a virtual storehouse for ideas which can then be referred to at any point during the formulation of their final products. Students were given a handout with the details for accessing and sending messages to the mediaBoard, and they were encouraged to send test SMS messages to the board during the seminar to help them learn how to send them.

mediaBoard also has the facility to be able to send SMS text messages to members of a board. An SMS message was sent to all the students to encourage them to use the mLearning LO before the Tate Modern visit so that they were more fully informed about how to use the mediaBoard.

> "Could those of you going to the Tate Modern please go to http://www.rlo-cetl.ac.uk:8080/rlos/mboard/index2.html. The tutorial will only take about 10 minutes and it will give you an opportunity to learn about using mobile technologies while fulfilling your assessment brief. Please answer the short questions after use. Many thanks ..."

We also started using the mediaBoard SMS facility to send regular messages to students, giving them weekly learning hints. These learning hints included reminders about deadlines and learning resources that became available that could help them complete their assignments. These were sent to students over a 7 week period, usually each Wednesday, before teaching took place on the following Friday. Examples of some of the text messages sent can be seen in Table 5.

Table 5: Examples of SMS messages sent to students

Use of the mediaBoard

We monitored the use of each of the team's boards for the duration of the assignment, but there was not much activity after the initial test messages were sent. 3 students contributed messages. One student in Team 4 posted 5 messages and images over a 14-day period from a mobile phone and from a PC. Beginning with a social message saying that it was nice to meet her team mates and that she looked forward to working with them, she then posted another 4 messages after the Tate visit, with images and suggestions for products they could take forward. Some of these messages are shown in Figure 3.

One student posted a message to arrange with his team how to get to The Tate, and another sent a message whilst at The Tate, saying they couldn't find where to go.

Overall, we were disappointed with the level of use of the mediaBoards, and investigated the reasons why in the student evaluation that was planned to take place later in the module.

Figure 3: mediaBoard in use by Team 4

Evaluation of the mLearning elements

Evaluation of the mLearning intervention had been planned from the outset of the project introduction, to find out the students' views about it, and to determine the level of success. We monitored the use of mediaBoard, and gave students a questionnaire to complete after the assignment was finished. We also asked the students for feedback on the SMS messages sent and the lecturer provided some reflective feedback.

40 students completed the evaluation questionnaire, about a 57% completion rate. Only 2 of these students said that they used mediaBoard to communicate with their team. The main reasons given for not using it were that they didn't really need it, because they either went to the Tate together, or they communicated by other means (several said they used their mobiles to send messages or call their team mates). Some simply said they didn't use it, without giving any reasons why. Only 37% said they enjoyed using the mediaBoard. 43% were concerned that other teams could see their discussions/ideas. Two students actually made comments in the questionnaire about not wanting other teams to see their ideas, whereas conversely another student liked this aspect and thought that this gave inspiration. In terms of usability, only 39% found it easy to send messages to the mediaBoard. 2 students made comments about it being 'a bit confusing', 2 said they didn't understand it, one said it was 'tedious' and another 'inconvenient'. However, 79% said that they were happy to use their mobiles for this exercise, with 50% being concerned about the cost of sending messages to mediaBoard (the other 50% were not concerned about the costs involved).

Here are some of the qualitative comments that students made about mediaBoard.

If you used mediaBoard, what did you like about it?

> "It acted as a central unit where info gathered could be stored, accessible by other team members. It was good to see other team's responses on the board - inspiration."

If you didn't use mediaBoard, what were the reasons?

> "We went together to the Tate and we go to all our lectures and seminars together so we had no need for it in terms of communication."
> "Contacted via other communication. Didn't need to. Other people could see your ideas."

Other comments

> "I would use media board as an alternative if I can't meet with my group."
> "Would be good if we could upload documents i.e. Word."

Surprisingly, given the levels of usage, enjoyment and engagement of mediaBoard, 56% said they would like to use mediaBoard again for another module or project.

We also asked the students for feedback on the SMS learning hints that we had sent them. In the mobile phone survey completed by the students at the beginning of the module, the majority had positive views towards the university contacting them via their mobile for learning purposes (45% were positive, 33% were neutral and 22% had negative views). However, we wanted to get direct feedback on the messages sent, to see if the students thought that they were helpful, and not an irritation or an invasion of their personal space. Feedback was gathered via a post-it note exercise in the last 2 seminars (a technique used successfully before by the lecturer to get instant reactions from students on something). The lecturer asked the students "What did you think about receiving text messages to your phone?" The question was written up on the whiteboard, and the students were asked to write their response to it on a post-it note that they were each given, which were collected at the end. 17 students wrote responses, and they all made some positive comments, even if there were some criticisms as well. A sample of the responses is

shown in Table 6. Two students said they hadn't received the messages (having either started late or having changed their mobile number), but both said they felt messages would be useful reminders for students. 6 students said the messages were 'useful', 5 said they were 'helpful', with 1 saying they were both 'useful' and 'helpful'. Other adjectives used to describe them were 'excellent', 'great' and 'really nice'. 3 of the students actually thanked us for sending them the messages.

Insert Table 6: Some responses from students about the 'learning hint' text messages sent them

This feedback is extremely encouraging, and indicates that if timely and useful messages are sent to students that help them in some way, they are pleased to get them.

The lecturer also provided some reflective feedback on the incorporation of mediaBoard into the module. She felt that it was a really good idea, and that it can assist students to bridge some of the 'time and space' barriers needed to be overcome for group work to be successful. However, the workload for the team was quite overwhelming, mainly due to the unexpected student numbers (requiring 2 seminar groups), and the amount of time required to set up the mediaBoards, producing explanatory handouts and the learning object, getting student details and registering them for the boards. More thorough preparation in terms of preparing resources in advance could have alleviated some of this pressure. Team roles blurred as everyone 'mucked in' to provide support and make it work. Some technical hitches also hindered students' understanding, for example in one of the seminar groups we could not get an Internet connection to demonstrate the mediaBoard online. The tutor also felt that she could have been more confident with the technologies being introduced. She also felt that it would work much better with being integrated more fully with the whole module pedagogic context, with the pilot being a bolt-on to an already crowded curriculum.

Whilst the level of use of mediaBoard was disappointing, the students do show a positive attitude towards it. We considered that its incorporation into the module would facilitate the communication and teamwork amongst the student groups, but this did not happen in reality. We didn't follow-up the student questionnaire with interviews, as we considered the level of use too minimal to pursue, and didn't want to over-burden the students with even more evaluation feedback. In addition to the comments made by the lecturer, the team proposed a number of reasons. Several students in the questionnaire mentioned that they used their mobiles to communicate with their team by SMS or voice calls, and one theory proposed by the team was that the high percentage of ownership of mobile phones changed the way that the students communicated from previous years. The usability issues mentioned also probably contributed to lack of use. Each type of message (SMS, MMS, email) has to be sent using a different convention, which is difficult to remember without having access to the handout or the learning object every time a message is sent to mediaBoard. In addition, because of the large numbers of students that eventually signed up to the module (80 as opposed to the envisaged 20), it was difficult to support and help them.

Conclusion

The introduction of mediaBoard into the module as a means of facilitating student group communication and completion of their assignment was well founded. Whilst most groups did not make use of their mediaBoard, the one that did showed that it could be helpful. Student feedback confirmed that they didn't feel the need to use it, but 56% said that they would like to use mediaBoard gain for another module/project, so they must be able to see the value of it. We can claim therefore that our blended m-learning design has the potential to support teamwork and social discourse for our students.

Our findings also indicate that if handled with sensitivity, students welcome SMS 'learning tips'. Obtaining learning hints in the convenient medium of their own mobile phone fits into the students' overall university life balance and time management requirements and is therefore seen in a positive light.

The key question posed in the introduction was: What combination of instructional strategies and delivery media will best produce the desired learning outcome for the intended audience? As a consequence of the work described in this paper, we feel that the effectiveness of our design revolves around three key aspects: (i) hooking into learner-owned mobile technologies, (ii) providing SMS learning hints in a timely manner, and (iii) providing links through to more substantial e-learning resources that are appropriate to the task in hand (mediaBoard and learning objects). Future work is currently extending the use of this blended mLearning model to other modules and subject areas.

Acknowledgements

We would like to thank all the students who took part in this study. The Centre of Excellence in Teaching and Learning in Reusable Learning Objects is funded by the Higher Education Funding Council for England. mediaBoard has been developed and is hosted by Cambridge Training and Development.

References

Bradley, C. and Haynes, R. (2005). *"Prototypes for multimedia mLearning"*. In Isaias, P., Borg, C., Kommers, P., & Bonanno, P., (Eds.), Proceedings of the IADIS International Conference on Mobile Learning 2005, June 28-30, Qawra, Malta, pp 3-10.

Cook, J., Holley, D., Smith, C., Haynes, R. and Bradley, C. (2006). *"Team Enhanced Creativity: An approach to Designing User-Centred Reusable Learning Objects"*. IV International Conference on Multimedia and ICTs in Education (m-ICTE2006), Seville (Spain), 22-25 November 2006. See http://www.formatex.org/micte2006

Corlett, D. & Sharples, M. (2004). *"Tablet Technology for Informal Collaboration in Higher Education"*. Proceedings of MLEARN 2004, Learning Anytime, Everywhere, Rome, 5-6 July.

Holley, D and Dobson, C. (2005). *"Eroding time and space dimensions: using multi-media to enable non- traditional student participation at an inner-city University in the UK"*. ED-MEDIA – World Conference on Educational Multimedia, Hypermedia & Telecommunications, 28 June - 1 July, Montreal, Canada.

Holley, D, Andrew, D, and Pheiffer, G. (2004). *"Exploring the Usefulness of New Technology with New Students: a case study"*. Investigations in University Teaching and Learning 2 (1), London Metropolitan University.

Kiddie, P., Marianczak, T., Sandle, N., Bridgefoot, L., Mistry, C., Williams, D., Corlett, D., Sharples, M. & Bull, S. (2004). *"Interactive Logbook: The Development of an Application to Enhance and Facilitate Collaborative Working within Groups in Higher Education"*. Proceedings of MLEARN 2004, Learning Anytime, Everywhere, Rome, 5-6 July.

mediaBoard website. Retrieved November 14, 2006, from http://www.mediaBoard.co.uk

Trollip, S. (2005). *"The giant leap towards mLearning innovations vs the small steps of lessons learnt"*. Keynote talk at 4th World Conference on Mobile Learning (MLEARN 2005), Cape Town, South Africa, October 25-28

Table 1

Mobile phone features

Phone features	Colour screen	Camera	Internet/WAP	3G	Bluetooth	WIFI
% of ownership	68%	68%	56%	14%	41%	1%

Table 2

Is the ability to learn at any time and in any place important to you?

	Extremely important	1	2	3	4	5	Not at all important
Q1 Is the ability to learn at any time and in any place important to you?		38%	24%	23%	6%	9%	

Table 3

How useful would it be to access learning materials via your mobile?

	Extremely useful	1	2	3	4	5	Not at all useful
Q2 How useful would it be to access learning materials via your mobile?		26%	13%	20%	22%	19%	

Table 4

How would you view the university contacting you via your mobile for learning purposes?

	It would be a positive aspect	1	2	3	4	5	It would be a negative aspect
Q3 How would you view the university contacting you via your mobile for learning purposes?		32%	23%	22%	10%	13%	

Table 5

Examples of SMS messages sent to students

"bssmstudy e-learning - check referencing tools + get your report right"
"Reflective writing due Friday. See reflective writing tool online"

Table 6

Some responses from students about the 'learning hint' text messages sent them

"It started to bug me but was useful."
"I got them and I liked the ones during the Easter break, which were giving suggestions about the report."
"I thought the text messages were great because every time I forgot about it I had someone pushing me to get on with it.
I really like to receive the text messages. I do think it is very useful. Thank you so much to send them to us."

Figure 1. Screen shot of learning object 'How to use mediaBoard'

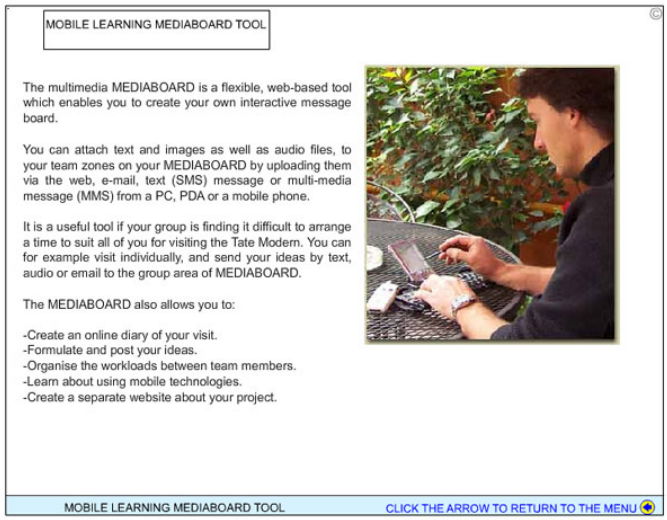


Figure 2: The mediaBoard for teams 1-10 in seminar group 2

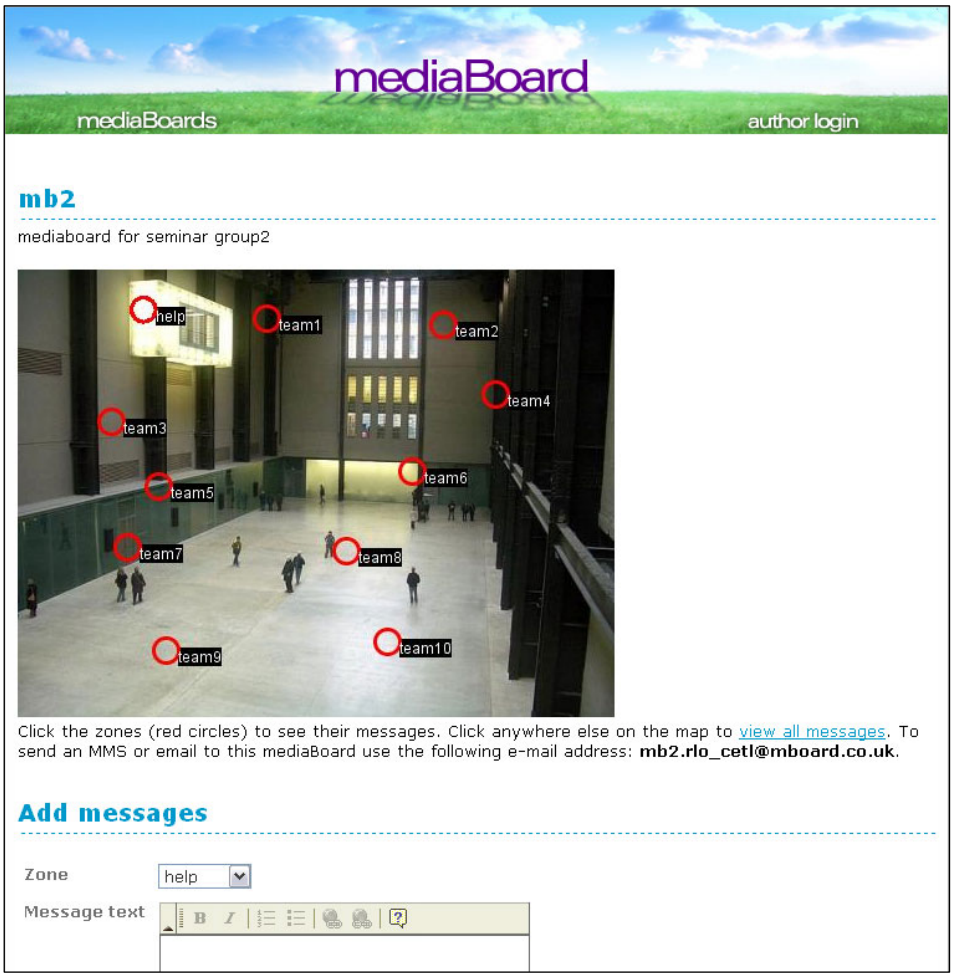
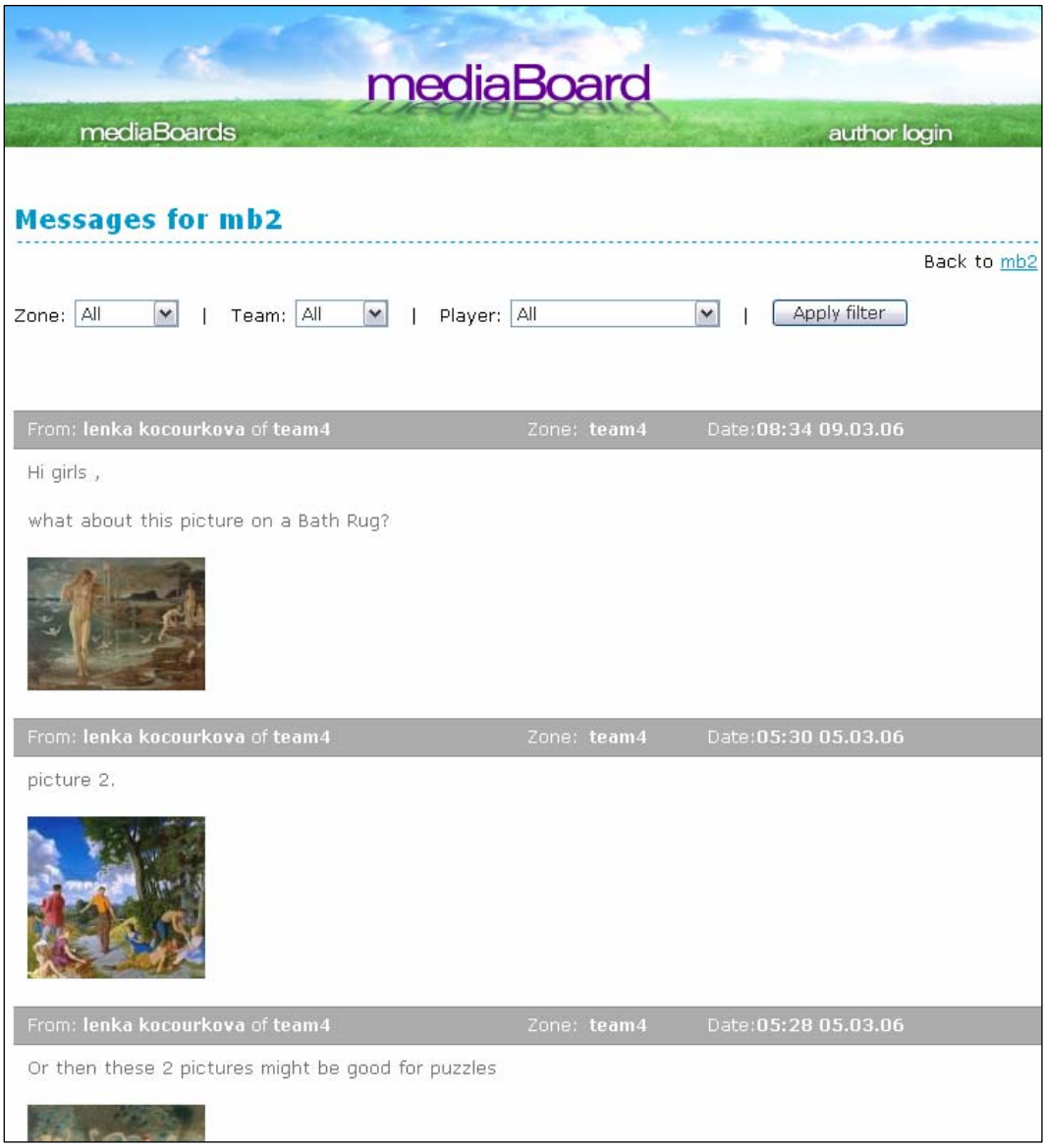


Figure 3: mediaBoard in use by Team 4



A perspective in lifelong learning: m-learning for TT management training

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Abstract

This paper focuses on an experience of blended learning (blended e-learning and blended m-learning). This experience is ongoing at present for the training of managers of Technological Transfer (TT), who work in an Italian Scientific Technological Park (STP). The main activity of the STP is linked to technological transfer. In the STP the technological transfer manager is the key figure in the management of the transmission of scientific knowledge from the research world to the industrial dimension. In Italy there are various initiatives for the training of the TT manager, from universities and other public agencies, not referable to the academic institution in a strict sense. These projects, even though they are relevant in the Italian framework, do not satisfy the training demand of TT managers. First of all, the training model used in these experiences is still the traditional lesson face to face, and possesses an extremely abstract character. Secondly, there is the problem of time. Typically, the TT manager does not have long periods of time to spend on training during his work day.

The aim of this study is to make an experiment in a “Training course for the manager of technological transfer” in order to satisfy the training needs of the TT manager.

The course is based on the blended learning model, with the use of combined traditional educational methodologies which are:

1. e-learning methodologies in the first part;
2. m-learning methodologies in the second part.

In this paper, the experience of blended e-learning will not be described thoroughly, but will focalize on the blend m-learning experience, giving details of all its phases.

A perspective in lifelong learning: m-learning for TT management training

Introduction

This paper focalizes on an experience of blended learning (blended e-learning and blended m-learning). It is ongoing at present for the training of managers of Technological Transfer (TT) who work in an Italian Scientific Technological Park (STP).

Scientific technological parks

The main activity of the STP is linked to technological transfer. STP is a structure where companies can find valid support in terms of space, technologies and financing. STP is a privileged access channel for innovation and applied research, thanks to a system of integrated services available for companies situated inside the park and also for those all over the entire surrounding territory. Until 1995 there were only 3 STPs in Italy, at present there are 33.

The manager of technological transfer

In the STP the technological transfer manager is the key figure in the management of the transmission of scientific knowledge from the research world to the industrial dimension. The TT manager has various levels of competences and is able to talk to the research world as well as to industry. The TT Manager has the task of turning the functions-objectives of the research world towards the demands of industry and of government and also of simplifying the knowledge transfer from the research world to the business one (Diamantini, 2004).

Training TT Managers

The dynamics of innovation, even if they are very important for the national socio-economic system, are a circumscribed phenomenon (Lundvall, 1992; Patel and Pavittt, 1994). Because of the limited number of interested subjects and of the necessary high profile of excellence and of the enormous quantity of competences involved, the training processes must be considered the training of a highly specialized elite.

From the training of TT managers, various difficulties emerge when designing models for specific training situations. A first difficulty is tied to the formalization level of the highly specialized expertise, which constitutes the central nucleus of the competences on which the activity of the TT manager is based. Some of these competences can be based on knowledge linked to a concrete know how, others on an abstract and theoretical know that. However, it is clear that knowledge which is based on strictly academic educational processes, characterized by a high level of abstraction, translates into highly specialized training models which is often far away from the concept of problem solving. Instead, in the everyday scene the TT manager has to solve concrete problems, where not only academic-theoretic knowledge is required, but also practical knowledge. Therefore, the knowledge that a TT manager needs to do his work well must be composed of a complex mix between theoretical competences acquired from study and a set of practical competences, experience and know how accumulated in a professional ambit.

In Italy there are various initiatives for the training of the TT manager, from universities and other public agencies, not referable to the academic institution in a strict sense. These projects, even though they are relevant in the Italian framework, they do not satisfy the training demand of TT managers. First of all, the training model used in these experiences is still the traditional lesson face to face, and possesses an extremely abstract character. Secondly, there is

the problem of time. Typically, the TT manager does not have long periods of time to spend on training during his work day.

The blended learning course

After an analysis of the complex situation illustrated in the previous paragraphs, it was decided to make an experiment for the “Training course for the manager of technological transfer” in order to satisfy the training needs of the TT manager. This experience, which began in January 2005, is still ongoing in the STP Polaris, which was founded in 2003. It is about 40 km. from Cagliari.

In the Italian framework, the methodologies that were used are what are new about the course. The course is based on the blended learning model, with the use of combined traditional educational methodologies which are:

- e-learning methodologies in the first part;
- m-learning methodologies in the second part.

It was decided to use the blended learning methodologies since it is believed that both e-learning and m-learning present a series of pros and cons, as in all new applications. Therefore, the forms of blended learning are able to take advantage of the benefits of the technological innovation without having to sacrifice the strong points of the more traditional and consolidated modalities of a classroom setting.

The sample

The sample is made up of 15 people, of which 5 are men and 10 are women, between 29 and 43 years old (average age = 39,7). These people, after their university degree, in some cases

(6) they have a Master's degree and in other cases (2) they are working on their Doctorate degrees.

Blended e-learning experimentation

The experimentation of the blended e-learning model was made on four levels.

1. *needs analysis,* in this step the company indicates the organizational and individual shortages. The analysis of needs is supported by competency models which indicate learning and competences to be developed, through subsequent educational processes.
2. *design of the interventions,* educational interventions are designed after the training objectives which are intended to be followed and the modality of transmitting the competences of the models which have been selected.
3. *delivery of the training,* education processes are delivered, they are structured in further evolutive cycles that make the creation of new learning effective.
4. *assessments,* in this conclusive phase new elements which are produced and interiorized are integrated. They become part of the organization which codifies and assimilates them by making them part of the common patrimony shared by its members.

In this paper, the experience of blended e-learning will not be described in detail but will focalize on the results of the assessment phase, since these results were the starting point for the design of a blended m-learning experience.

Criticality which emerged in the course of the blended e-learning experimentation

There were three instruments used to analyze the results obtained from the blended e-learning experimentation. There was the double objective of understanding the qualities and characteristics of the sampling and the positive and negative aspects of the course:

1. a questionnaire about the correlated competences for a personal development plan (PDP), in which the objective was to show aptitudes and competences of the students;
2. assessment forms of the learning modules taken, used to identify the strong and weak points of the modules;
3. in depth interviews of the students to integrate with the questionnaires in order to finish the profiles.

The assessment shows that, on one hand, the students judged the contents positively; on the other hand, there is the limit created by the mental representation of a computer (understood as a desktop computer), which is seen only and exclusively as a work instrument and not as a lifelong learning instrument.

The students had difficulty becoming familiar with the computer instrument as a training and communication instrument and not only a work instrument. The first level of analysis is to represent the work instrument: all students work on a personal computer, but none of the students have taken an online course. Therefore representing the work instrument as a training instrument requires the structuring of an appositive learning path. For example, a pre-course would be useful to help the student become familiar with the instrument. According to the students an entry test would be useful, as a means to understand how the learning instrument can be effectively used.

Furthermore, as it was shown by the tracking of the platform accesses, almost all the students came on the platform during the work day at precise times. This let us understand how

the computer instrument is not a training instrument in the immediate future and how the training is not perceived as a continued and continuative process, but is still seen as a moment in itself that must not go beyond certain times during the day.

The blended mobile learning course

It is thought that m-learning can make up for the criticality that characterized the blended e-learning experience. In the blended m-learning we decided to:

1. administer a pre-questionnaire in order to understand how the learning instrument could be best used;
2. to familiarize the students with the instrument through: a first face to face meeting of the course where the Pocket PC is presented and distributed to the students; the fruition of a learning unit on mobile learning and a second face to face meeting to share doubts about the new learning typology.

In particular, it is thought that the mental representation of a mobile device is different from a desktop computer for the following multiple reasons:

1. the versatility and the wide use of the mobile device for teaching, a palmtop for example, easily becomes a multimedia screen for listening to music, looking at pictures and films;
2. as underlined by Graham (1997), Steinberger (2002) and Figg and Burston (2002), it is so easy to learn how to use a mobile device that normally an instruction booklet is not even necessary. In less than half an hour a new user is able to become familiar with the main functions of a new device and to acquire familiarity with its software in order to autonomously attend a course. This is due

to the fact that the major part of the users are using similar devices everyday, such as mobile phones. This consideration is not true for a personal computer where the lack of knowledge of the computer environment requires training sessions for at least one day for someone who does not have familiarity with a computer. It may require more time for the use of applicative environments.

3. the mobile device, different from the desktop computer, which for many people is bound to the work and the office environment, now accompanies the majority of the Italian people practically all the time and everywhere.

The experience of blended mobile learning can be divided into the following phases:

1. face to face meeting with the students, during which a pre-questionnaire is administered and the PocketPC is presented and distributed to the students;
2. fruition of a learning unit on mobile learning;
3. face to face meeting with the students to share doubts about the new learning methodology;
4. fruition of the didactic module on one of the topics taken from the needs analysis done in phase 1;
5. face to face meeting with the students for a discussion of their observations and the administration of the assessment questionnaire about the experience.

The experience, as previously explained is ongoing. Following, after having explained the model and the teaching strategies used, a brief explanation will be made of the didactic modules, the pre-questionnaire and the assessment questionnaire.

The Model and Didactics Strategies

The transformations in the current didactics used for mobile learning are mainly linked to the fact that the learning activity takes place through a new tool – the mobile device. And, just as on line didactics differ from face to face didactics, didactics via mobile devices must also take into consideration some elements that differ from face to face and on line didactics.

Obviously, these elements are not linked exclusively to the mobile device in itself, but to the peculiarities of mobile learning (that is the time gaps and places of its fruition). Just as on line didactics cannot be a simple transposition of personal didactics in the most traditional sense, the same is also true for didactics via mobile learning – it cannot be a mere transposition of on line didactics.

From the tests and studies carried out so far, it seems that they are quite flexible technologies which can support various models, from those based on the transmission of contents to those based on interaction, experience and the building up of knowledge.

Starting with these considerations, in each mobile learning object we decided to let the transmission of contents be followed by a topic for reflection or by homework, the results of which were shared during the next face to face meeting.

To create this didactic unit, the guidelines of Steinberger (2002) and Figg and Burston (2002) have been taken into consideration. According to them (as quoted by Trifonova and Ronchetti, 2003), “Modules should be short, and last no more than 5-10 minutes. Users should be able to use their small fragments of waiting or idle time for learning, by reading small pieces of data, doing quizzes or using forums or chat. Simple, fun and added value functionality. The computational power and other properties of mobile devices make it difficult in most cases to use complex and multimedia content, although devices of the same size are used for entertainment with great commercial success. It should be possible to use an m-learning system without

reading a user manual, and the experience of studying with the help of such devices should be interesting and engaging.”.

Introducing the contents to promote learning, we have followed the suggestions made by Mayer (1999). Thus, as this Californian psychologist affirms, we have:

- underlined the most significant information using titles, italics, bold, underlining, font sizes, icons and images;
- explained didactic purposes in order to claim the attention of the participants on the main contents;
- supplied short summaries;
- cancelled information and adopted a concise style in order to reduce “noise”.

To make it easier for the student to organize and process the new information, and help him to connect the selected representations in order to create a coherent mental representation, we have tried to:

- structure the text in a clear and comprehensible way, in particular we have explained the conceptual relations among its parts (cause/effect, confrontation/comparison, classification, and so on);
- supply an “outline” with the crucial passages;
- indicate the passages using key words;
- supply graphic representations to correlate the new concepts (i.e. schemes).

The Pre-questionnaire

The pre-questionnaire was created by selecting thematic areas from a survey made on scientific literature regarding mobile devices in general, and mobile learning in particular. It is divided into four parts.

In the first part, some free associations are requested (max 5) for four concepts – stimuli: mobile telephones, desktop, notebook and handheld computer. In the second part, participants are asked to give their opinion about the associations they gave: positive (+), neutral (0) or negative (-) ratings.

In the third part, they had to answer some questions about their own mobile devices and their use.

In the last part, some social-personal questions were asked, such as sex, age, residence, education, profession, average time to reach their place of work and the use of Internet.

The goal of this questionnaire is to understand how the learning instrument can be used, something which was not done in the blended e-learning experience. For this it is necessary to understand what mobile devices our subjects have, how they use them and how they are willing to use them.

The didactic modules

The didactic modules, in text format (ppt) and audio, constitute the learning objects which last approximately 10 minutes each. Every mobile learning object has a contents part followed by some reflections to follow (for example: “Try to reflect on one of the topics that was just presented to you …”) or a task to do (for example: “Collect material on one of the topics which was just presented ….”). The results of the reflections and the tasks will be shared with

the participants of the course in successive face to face meetings which will lead to the co-construction of common knowledge.

The Assessment Questionnaire

The areas to be investigated in the assessment of the quality of the mobile learning experimentation have been identified also in the literature about mobile learning. In particular, we have considered:

- the features of fruition typical of mobile learning, such as the chance to access the training contents anywhere and anytime;
- the features of the mobile device in itself, in this case the PocketPC, both in terms of hardware and software;
- the way the user feels the mobile device is as a learning tool;
- the structuring of the course both in terms of content organization the stimuli and homework assignments proposed.

The result expected from the analysis of the results obtained in the various areas, and considering the importance of the various *gaps*, had the purpose of identifying the areas of the training process where an intervention should be made in order to maximise the participants' satisfaction towards the training processes.

Regarding the features of the mobile devices in themselves, if subjects have never used a PDA before, they are asked if they had any problem using the Pocket PC. They are also asked to assess the following aspects using a 5-point Likert scale:

- readability of the contents on the screen;
- use of the pen;

- surfing and menu changing;
- screen colours;
- battery life;
- audio.

As for the fruition features, the space and time gaps during which the mobile device has been used to benefit from the didactic unit have been investigated and it has also been asked if using the PocketPC in public has been easy and accessible, or if it has been difficult. And if some difficulty was experienced, the student had to specify if it was caused by lack of concentration, reception, reading of the screen or by some other factor.

Regarding the course contents and organization, after a question about a general assessment of the course, the students are asked to assess, using another 5-point Likert scale, the proposed topic and its relationship with their training path. The students are asked to assess the stimuli and the homework assignments proposed at the end of each single mobile learning object, and also the final meeting with the trainer.

Finally, they had to indicate the three positive and the three negative points of the module and also the main problems they had found, making suggestions regarding the development of the module offered to them.

Conclusions

From this still ongoing experience of blended m-learning, it seems that this training method better suits the needs of TT Managers than blended e-learning. For example, mobile learning allows trainees to use times and spaces (i.e., the time for the transfer by bus from the city to the STP) which formerly, with blended e-learning, were “lost” to training activities. The

work with blended m-learning shows also that there is a need to develop teaching strategies that focus on those experiential elements capable of strengthening learning, building what in contemporary literature is called “learning experience”.

References

Diamantini, D. (2004). *Il manager dell'innovazione. La formazione nelle professioni del trasferimento tecnologico*. Milano: Guerini e Associati.

Graham, B. (1997). "The world in your pocket – using pocket book computer for IT". *Social Science Review*, 79 (287), 45-48.

Figg, C. and Burston, J. (2002). PDA Strategies for Preservice Teacher Technology Training. *14th World Conference on Educational Multimedia, Hypermedia and Telecommunications*, Denver, CO, USA.

Lundvall, B. A. (1992). *National Systems of Innovation: towards a theory of innovation and interactive learning*. London: Printer Publisher.

Mayer, R. E. (1999). Design instruction for costructivist learning, in Reigeluth, C. M. (ed.). Instructional-design theory and models. New York – London: Lawrence Erlbaum Associates, 141-159.

Patel, P. and Pavitt, K. (1994). "Uneven (and divergent) technological accumulation among advanced countries: evidence and a framework of explanation", *Industrial and Corporate Change*, 3 (3), 759-787.

Steinberger, C. (2002). Wireless meets Wireline e-Learning, *14th World Conference on Educational Multimedia, Hypermedia and Telecommunications,* Denver, CO, USA.

Trifonova, A., Ronchetti, M. (2003). “Where is Mobile Learning Going?”. *Proceedings of the World Conference on E-learning in Corporate, Government, Healthcare & Higher Education*, Phoenix, Arizona, USA, November 7-11, 2003. 1794-1801.

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Michelle Pieri, Phd in Psychology, is interested in distance learning, in particular mobile learning.

Table 1

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Figure Captions

Figure 1. Insert figure caption here.

Running head: SMS BASED QUERYING

An SMS Based Querying System for Mobile Learning

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Abstract

Mobile phone is the most widely used mobile device. Every mobile phone user can conveniently communicate with each other through SMS (Short Message Service) text messages at very low price. It is so commonly used that, in some countries like China, an SMS culture has emerged. Although there are some SMS based applications in m-Learning, most of them are only for administrative purposes, like delivering messages to students as reminders or alerts for some learning activities. In fact, text messages of SMS can effectively convey small pieces of materials related to learning processes, like course notes, items of glossary, small pieces of explanation and some links to detailed information etc. In this paper, we introduce a system for querying information and knowledge by the use of SMS in a mobile learning environment. The proposed system consists of a GSM Module (GSMM), a Dialogue Control Module (DCM), a Querying Processing Module (QPM) and a Knowledge Base (KB). GSMM includes a micro-controller and a GSM communication device with a SIM card in it. It processes the users' messages according to our defined protocol and acts as the interface between the mobile infrastructure and the rest of the system. DCM handles the content of the requesting messages and produces suitable querying tasks for QPM, which in turn searches and matches information from KB or Internet to produce suitable answering messages for the users according to their requesting messages. To help the system better understand the content of messages, natural language processing and theme recognition techniques are applied to message processing modules. Several scenarios about course notes and glossary querying are illustrated in this paper.
Keywords: short message service; GSM; knowledge querying; dialogue control; natural language processing.

An SMS Based Querying System for Mobile Learning

1. INTRODUCTION

Mobile phone market is growing very fast globally in recent years. According to the report of Pyramid Research, the mobile phone users will be 2.6 billion at the end of this year. More and more people are using mobile phones for business, education and personal activities in many countries, especially in developing countries. Among all the functions provided by mobile phone, Short Message Service (SMS) is regarded as the most money saving and convenient way of communication, and is still widely used for different purposes such as communication, entertainment, management and learning. For examples, in China, the world's largest and fastest growing mobile phone marketplace, SMS is the most popular and favorite mobile service. According to the monthly statistics of MII of China [MII, 2006], there are 443 million mobile phones by September 2006, and totally 310 billion messages delivered from January to September in 2006. In fact, as reported by XinhuaNet of China [Feng, 2006], the number of short messages has increased by 300 times in six years (from 1 billion messages in 2000 to 304 billion in 2005). Short Message Service has been employed by other service providers such as Internet service providers and media companies to deliver messages to their users or customers. Many people are willing to send greeting messages, poems or short stories by SMS, and a unique SMS culture, just like TV culture as we know, has emerged and been recognized in China.

Compared with other online functions such as tone service or Web browser of mobile phone, an SMS message can be delivered at any time you like, and automatically stored where it can be re-read, which proves particularly useful in the case of fairly detailed information that might otherwise be forgotten, such as test scores, booked class room numbers and short course

notes in education environment. For example, a teacher can deliver to students short questions or quizzes after class by using short message notifications.

There have been wide applications of SMS in E-Learning because of its advantages of convenience, popularity, low maintenance cost and so on. For example, SMS text messaging was used as an experimental method of providing a form of “mobile scaffolding” at a fundamental level to support those needs, and guide students towards independent self-management; i.e. creating a personal mobile support context for learning and doing [Stone, 2004]. Wang et al [Wang, 2003] employ mobile services including SMS to assist students with three kinds of information awareness (learning status awareness, schedule awareness, and mentor awareness) to promote learning performance of students. As mobile learning becomes more and more regarded as a future of learning [Ragus, 2006], several projects have been launched in Europe, Asia and Africa [Keegan, 2004], which demonstrates that SMS is one of the important ways to support managing, teaching and learning. For example, Cell phones prove to be a suitable way to leaning English on the air with the help of both SMS and MMS for delivering leaning content [Collins, 2005]. However, most of the current applications of SMS in e-learning or mobile learning are about delivering simple predefined messages for notifications or alerts to facilitate management or learning support. In this paper, we focus on the structure and functions of a system for querying information and knowledge by the use of SMS text messages, which can convey small pieces of materials related to learning processes, such as items of glossary, small pieces of short course summaries or examination preparation notes, student guidance, answers to exercises, second language learning tips etc. in a mobile learning environment.

The remainder of this paper is structured as follows. In the second section, we present the structure of the system and discuss each of the four modules of the system, while giving more

details on dialogue processing; in the third section, we introduce several simple scenarios to explain the functions of the system that is still under construction; we shall finish with some conclusions and further work.

2. SYSTEM OVERVIEW

In this section, we introduce the structure of our system which is to support students to query information and knowledge through SMS in a mobile learning environment. The system consists of a GSM Module (GSMM), a Dialogue Control Module (DCM), a Querying Processing Module (QPM) and a Knowledge Base (KB), as depicted in Fig. 1. By receiving from and sending to users messages through the GSM network, GSMM acts as the interface between the mobile infrastructure and the rest of the system. The processed requests are then transferred to DCM, which handles the content of the requesting messages and produces suitable querying tasks for QPM, which in turn searches and matches information from KB or Internet to produce suitable answering messages for the users according to their requesting messages.

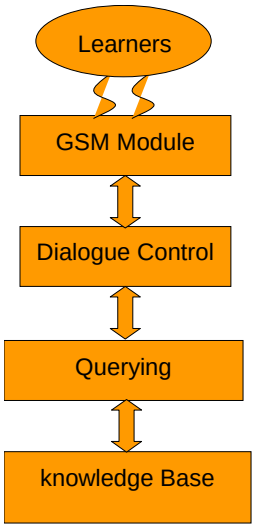

Figure 1. The system structure

2.1. GSM Module

GSM Module consists of a GSM communication device with SIM cards in it for connecting with GSM networks, and a micro-controller (MCU), which processes messages coming from the GSM communication device and communicates with upper computer hosting DCM and other modules. Its hardware structure is depicted in Fig. 2.

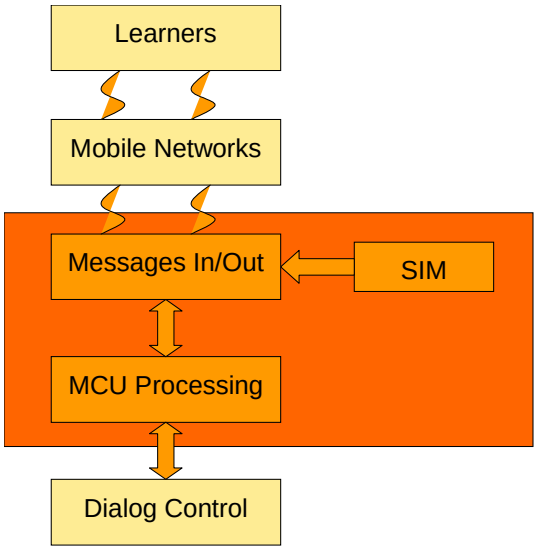

Figure 2. The hardware structure of GSM

The main function of the program running on the micro-controller is to handle the communication with both upper computer and GSM device, to process the user request messages according to certain pre-defined message protocol, and to transfer them to the dialogue module for further processing. We use Siemens TC35i hardware module as the GSM communication device [Siemens AG, 2003], and use Atmel AT89S52 micro-controller as MCU to control the TC35i module by sending AT commands [Siemens AG, 2003]. For instance, MCU uses command AT+CMGR to read the content of a short message that comes from a student through mobile networks. After MCU sends the AT command, GSM hardware module will reply messages to MCU. If it succeeds, MCU will receive data OK. If not, MCU gets data ERROR. Similarly, more communications and tasks can be done through other AT commands. Figure 3 shows the flow chart of the message receiving and sending involved in this module.

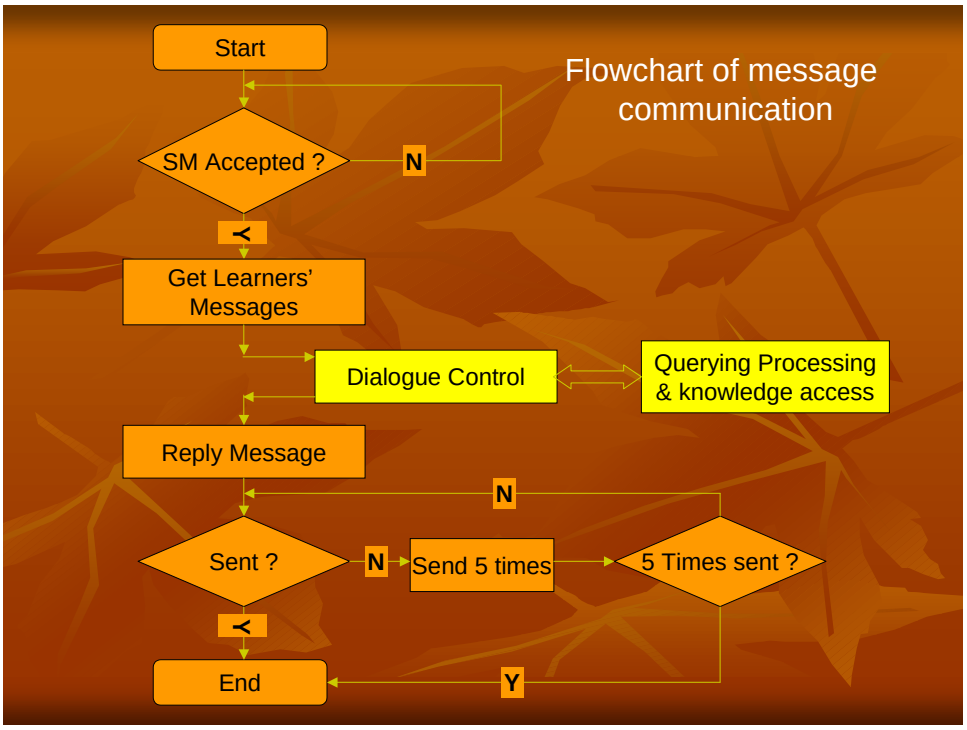

Figure 3. Receiving and sending message

The GSM module keeps awake to receive short messages from students, and transfer them to the dialogue control module, and deletes the successfully transferred short messages to save space. It is also responsible for sending answer messages from the dialogue module to the students in a robust way.

2.2. Dialogue Control Module

The main task of the Dialogue Control Module is to control the dialogue between the students and the system. Most of current systems involving SMS in education do not need this task, because they only need to SEND to students some information by short messages. As a querying system, dialogue control is inevitable here because the system needs to RECEIVE and RECOGNIZE the request messages from the students first and try to give the relevant answers to the students. If the information in a message for a querying is not complete, the system may need

to ask uses for confirmation and then give the right answers. Also, if it needs several steps to complete a certain querying process, i.e. several sending and receiving turns between the system and a student, the state of the dialogue need to be stored. So, recognition, confirmation and statefulness are critical to the dialogue control module in our querying system. The tasks of this module are as follows:

- Handling the content of the requesting messages
- Controlling the dialogue process
- Producing suitable querying tasks for QPM

Currently, there are several ways of modeling dialogue process, namely:

- Querying protocol based (Structured message) systems;
- Pattern matching based systems;
- Finite state based systems;
- Frame based systems; and
- Agent based systems.

Among these systems, agent based systems are designed to permit complex dialogues, while the protocol based systems can provide the minimum dialogue process. McTear [McTear, 2002] has presented a very good introduction to some of the systems. However, our system is not designed as a pure dialogue system. Instead of long dialogues, the purpose of our system is to provide information and knowledge querying with the help of relatively simple dialogue process with at most 2-3 turns. As a querying system, it functions between Question-Answering and the Spoken Dialogue Systems. With this understanding, we build the dialogue process module based on both querying protocol for structured request messages and frame approaches for multi-theme natural language text messages.

We will explain the protocol-based application in scenario 1 in section 3, while focusing on analyzing the unstructured text by frame based multi-theme dialogue control and Natural Language Processing (NLP) in this section.

To recognize the theme of a request message, a set of describing words is predefined for every registered querying theme of the system. For example, if a user's input includes key words such as TEST, PAST, SCORE, a course name like COMPxxx etc. then he may have the intention of querying the score of the course. For the cases that an input text message includes different key words from different themes, an algorithm from [Chen; Wen, 2005] will be launched to resolve the confliction by user confirmation:

```
1.  T_t = T_1
2.  while t ≤ sizeof(registered themes)
3.  {
4.    for each describe word w of T_t
5.    if w is substring of I
6.      add T_t to Theme and break
7.    t = t + 1
8.  }
9.  if sizeof(Theme) = 1 return Theme
10. else return Confirm(Theme)
```

The algorithm starts from the first registered theme T_1, and then for each registered theme T_t, looks over its describing words dictionary. If any of the describing words w is the substring of the user's input message I, T_t will be added to the possible theme set Theme. After the loop, if the number of themes in Theme is only one, then the theme is the intention theme, or else a further confirmation will be taken to figure out the user's intention by calling a function Confirm(Theme).

If the incomplete information occurs when comparing the frame of a theme, the system should confirm the user's intention by asking the specific information lacking in the request message. And then the user will give a clearer answer.

The dialogue control is the core function of this module, which manages all the registered themes and controls dialogue flow. The control process can be summarized by the following frame-based dialogue control algorithm from our previous work [Chen; Wen, 2005]:

1. $S_i = ThemeRecognize(I)$
2. $S_t = S_{i1}$
3. while $S_t \neq S_F$
4. {
5. $A_t = NextAction(S_t)$
6. invoke A_t
7. O_t = environment response to A_t
8. $S_{t+1} = NextState(S_t, A_t, O_t)$
9. $t = t + 1$
10. $S_j = ThemeRecognize(I_t)$
11. if $S_i \neq S_j$ then $S_t = S_{j1}$
12. }

It is different and more advanced compared with traditional dialogue process algorithm [Levin, 1999]. At first, dialogue theme is recognized as S_i according to the user input I. Then it starts in the initial state S_{i1} of theme S_i. S_t denotes the system state at turn t. The function "NextAction" determines the next action A_t to be invoked, and the function "NextState" updates the state variables with the external observations. After that, a new user input I_t should be analyzed to recognize its intention S_j. If S_i is not the same as S_j, then system state should be updated to the initial state S_{j1} of theme S_i. The process repeats until a final state S_F is reached.

To facilitate understanding unstructured text of SMS message, we employ natural language processing to extract the appropriate key words and relevant values. A querying message in natural language provided by a user is first tagged by a Part-of-Speech tagger. In a sentence, the Part-of-Speech of a word correlates to its position in the sentence. For example, an adjective always appears before a noun. We can use Hidden Markov Model (HMM) to describe the Part-of-Speech possibilities, and WordNet [Fellbaum, 1998] is useful for this step, for it includes almost all of the possible Part-of-Speeches of the word. After a sentence has been tagged, the result will be processed by a syntax analysis module. Syntax analysis is defined to be the process to find the grammar tree for a tagged sentence, which is then combined with semantic analysis to support key words extraction and the theme recognition. More details about these topics can be found in our previous work in [Chen;Wen, 2005] and [Chen;Wen, 2006]. The flow chart is depicted in figure 4.

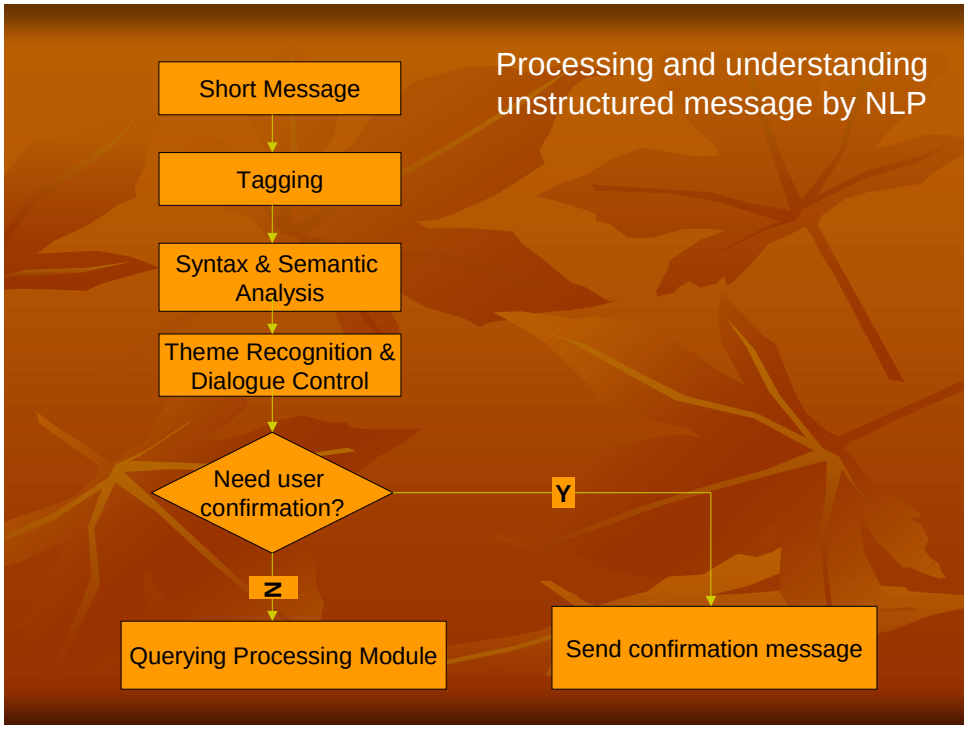

Figure 4.The flow chart of dialogue control and NLP

2.3、Querying Processing Module and Knowledge Base

The main tasks of the querying processing module are receiving the query requests from DCM, querying or searching information from database and/or knowledge base of the system, or from Internet, and then producing suitable answering messages according to their the requesting and sending them back to DCM. As you may have noticed, there are several different knowledge resources the system may access:

- Learning database, which includes predefined information of the mobile learning environment, depending on the categories and functions provided by the querying system.
- Cyc knowledge base [Siegel, 2004], a generic common sense knowledge base, also including specific information of some domains, which supports reasoning and complex knowledge querying, and provides CycL and Java API for applications based on it.
- Internet, querying the Internet on behalf of the students with the help of Google, Ask.com, or querying some knowledge intensive sites like Wikipedia.

We use different methods to query information according to different knowledge resources listed above. For example, we directly query information (by SQL) from the database according to the querying string conforming with the protocol, and the recognized theme and features, or query information with the help of Cyc knowledge base by CycL or Java API, or query knowledge from outside knowledge resources such as Wikipedia by Wikipedia API or Web pages on the Internet by Google Search API.

3. SCENARIOS

In this section, we present three brief scenarios to demonstrate the functions and applications of the system in different styles of messages and dialogue. The first scenario is to illustrate protocol based querying, while the second and the third are to illustrate the cases in which a user uses the natural language text messages for querying information or knowledge.

Scenario 1 – Protocol based querying

(1) A student sends "Get CN-3.3 COMP611 ", where all the words are following the predefined protocol;

(2) The system parses the string according to the protocol;

(3) Queries the database;

(4) Sends the result to the student.

Scenario 2 – Text based querying

(1) A student inputs a message "Did I past the last test?"

(2) By NLP analysis, the system recognizes the keyword TEST and the meaning of PAST (asking for the SCORE), finding insufficient information of the course name (Do not understand "last" at this stage.) for the SCORE theme frame

(3) The system asks "which course are you asking for?" then student gives the further answer

(4) The system queries the database and replies the score to the student.

Scenario 3 - Text based querying with access to knowledge base

(1) A student inputs a message "what is catalyst for?"

(2) By NLP analysis, the system extracts the word CATALYST and finds that there is no information about it in the local learning database.

(3) The system tries to query Cyc knowledge base, which happens to have a good collection of knowledge of Chemistry, and finds the definition of CATALYST.

(4) The system replies to the student the information produced by Cyc's paraphrasing about Catalyst (combining with concepts such as ChemicalReaction etc.)

4. CONCLUSIONS AND FUTURE WORK

In this paper, we have introduced the structure and mechanisms of an SMS based querying system. The system currently employs GSM communications, dialogue control and NLP based message processing to provide the knowledge and information querying in mobile learning environment. Although the implementation of the whole system is not finished yet, the GSM module and dialogue module, including the multi-theme recognition based on NLP have been done. The future work will focus on the implementation of the querying processing module, and knowledge acquisitions from knowledge bases and the Internet by integrating several APIs such as Cyc API, Wikipedia API and Google Search API.

References

Chen, Z., Wen, D. (2005). “A New Web-Service-Based Architecture for Question Answering.” *Proceedings of IEEE International Conference on Natural Language Processing and Knowledge Engineering* (IEEE NLP-KE’05) , 179-183, Nov. 2005.

Chen, Z., Wen, D. (2006). “Study and Implementation of Improving Question Answering Systems Using NLP.” *Computer Engineering*, 32(20), 205-223, (in Chinese).

Fellbaum, C. (1998). *WordNet: An Electronic Lexical Database.* Cambridge, Massachusetts. MIT Press.

Collins, T. G. (2005). “English Class on the Air: Mobile Language Learning with Cell Phones.” *Proceedings of the Fifth IEEE International Conference on Advanced Learning Technologies* 2005

Feng, X. (2006). “12600 million short messages delivered during Spring Festival in China” XinhuaNet, Beijing. Retrieved Feb. 8, 2006, from: http://news.xinhuanet.com/newmedia/2006-02/08/content_4149558.htm

Keegan, D. (2004). “Mobile learning: the next generation of learning.” *Proceedings of 18th AAOU conference, Quality education for all - New missions and challenges facing Open Universities*. Shanghai TV University, China

Levin, E., Pieraccini, R. etc. (1999). “Spoken language dialogue: from theory to practice.” *Technical report: AT&T Labs-Research*, 180 Park Avenue, Florham Park, NJ. Retrieved October 10, 2006, from: http://www.difabbrizio.com/papers/asru1999-spokenDialogSystems.pdf

McTEAR, M. F. (2002). “Spoken Dialogue Technology: Enabling the conversational user interface.” *ACM Computing Surveys*, 34(1), 90-169

MII. (2006). “The monthly statistics for communications industry of China in 2006.” Ministry of Information Industry of the People’s Republic of China. Retrieved October 11, 2006, from: http://www.mii.gov.cn/col/col166/index.html

Ragus, M. (2006). “Mlearning: A future of learning.” *The Knowledge Tree Goes Social* Edition 9 May 2006. Retrieved October 10, 2006, from: http://kt.flexiblelearning.net.au/wp-content/uploads/2006/05/ragus.pdf

Siegel, N. et al. (2004). “The Cyc System: Notes on Architecture.” Cycorp, Inc. Retrieved October 10, 2006, from: http://www.cyc.com/cyc/technology/whitepapers_dir/Cyc_Architecture_and_API.pdf

Siemens AG. (2003). *Siemens Cellular Engines TC35i AT Command Set*, Version 01.03, 2003.11.11. Siemens AG 2003

Stone,A. (2004). “Mobile Scaffolding: An Experiment in Using SMS Text Messaging to Support First Year University Students.” *Proceedings of the IEEE International Conference on Advanced Learning Technologies* 2004

Wang, C.-Y., Liu, B.-J. et al. (2003). “Using Mobile Techniques in Improving Information Awareness to Promote Learning Performance.” *Proceedings of the The 3rd IEEE International Conference on Advanced Learning Technologies* (ICALT'03).

Author Note

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Table 1

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Figure Captions

Figure 1. The system structure.

Figure 2. The hardware structure of GSM.

Figure 3. Receiving and sending message.

Figure 4. The flow chart of dialogue control and NLP.

Authoring design patterns for user & device dependant adaptive data presentation

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Abstract

In 2000 the iSign project started as a virtual web-based laboratory for students of study program electrical engineering. Continuous development in the last years led to a heterogeneous learning environment offering learning material, adaptive user settings and access to a simulation tool. Access is available via web and wireless devices such as PCs, Laptops, PDAs, smartphones and mobile phones.

Our attempt to adapt the content to the user's needs and the currently used device led us to a XML based data structure. This report shows our research results about content adaptation based on XML data. The two main aspects for that process are: the device capabilities and the adaptation methods using XML data.

Introduction

The accelerating evolution in the mobile device market has shown that it is more and more impossible to distinguish mobile devices on a rough and general classification such as PDA, smartphone or mobile phone [6]. One main result of the in-depth study was that this categorising is not a proper decision for solving the problem of capabilities dependant content delivery. As a conclusion we use a combination of all important capabilities to define the classification of the device (Chapter 2). During the recent years XML has been proven to be the adequate and powerful technology to store content in a presentation independent manner. We define an additional attribute inside the XML tags to manifest classifications (Chapter 3). At the same time this will help the authors to generate learning material for different devices in an efficient and structured way (Chapter 4).

To provide proper solutions to the problem of platform-dependant web content delivery and the storage of data in XML format, early attempts discussed providing two different presentations for desktop and mobile platforms [4]. Later, different studies concentrated on providing several presentations for different models [5] or categories [6] of mobile devices.

Device Classification

The new concept of device classification is based on isolating the important capabilities, described by classification parameters. These parameters can be combined to a vector which spreads out a parameter space. Finally the parameter space is transformed into a low-dimensional space which is then divided into the targeted number of classes. Figure 1, models an example space for an application, which is designed to offer 7 different presentations depending on the visual and connection capabilities of the devices. Note that the first presentation (class 1) is omitted as it is reserved by default to desktop devices (PCs and laptops). This new concept has

the advantage of flexibility in the selection of the classification parameters, and the number of classes. However, the more parameters are taken into consideration the more complicated the system gets.

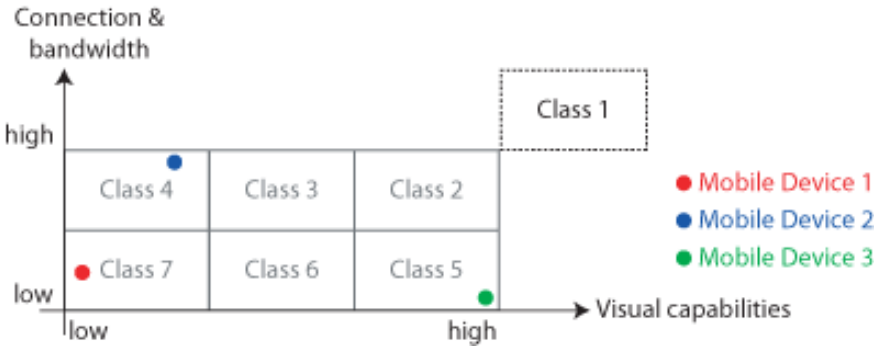

Figure 1: An example of 2 dimensional space divided into 7 classes

Devices classification factors

During the investigation the following general categories of classification factors were found:

Visual factors:

Currently, there is a huge variance in the visual capabilities of the available mobile devices in the world wide market. While there are a lot of visual limitations on an application which is running on a mobile phone with a small screen and limited number of colours, other more visual oriented mobile devices provide means for applications with advanced visual capabilities. Here comes the importance of enabling the same application to use the maximum visual abilities of the used device. The main factors that were found to vary from one device to

another are: the display size, the screen resolution, the screen size in characters, the number of colours and the orientation of the device.

Media factors:

The available mobile devices were found also to have a wide range of media presentation capabilities (i.e. acceptable MIME media types). While one mobile device may be able to present a media type with a certain file format, another may not be able to present the same media type or may have the ability to present it but needs another file format. These media types are text, images, audio and video.

Connectivity factors:

These are the connection speed and the Internet access method, which specifies whether the device is connected to the Internet via a Wireless LAN or a mobile network service provider.

Other factors that may vary from one device to another are: the supported languages, the memory size, the operating system and its version.

Factors Determination Methods

The following are the main approaches used by mobile web developers to evaluate actual values for necessary factors:

HTTP Request Headers:

Using HTTP request headers such as the user-agent header and the accept headers is the easiest approach to be implemented and the fastest from the performance point of view, but it has

some drawbacks. One problem is that it provides a very limited set of information about the user's browser like the accepted MIME types, preferred character set and accepted language set. Another problem is that browsers may not provide full or correct information. However, this approach can be effectively used to distinguish microbrowsers from normal ones, in other words, mobile devices from desktop devices (PCs and laptops).

CC/PP framework, UAProf:

The CC/PP (Composite Capabilities/Preferences Profile) framework is recommended by the W3C (World Wide Web Consortium) [2] as a standard for delivering information about the used mobile device. This standard defines the structure of the device profile based on the RDF (Resource Description Framework) [2], but it does neither provide any recommendation about the content of such profiles nor the way they are delivered and by whom. For this purpose, the UAProf (User Agent Profile) [3] standard is used which is defined by the OMA (Open Mobile Alliance) and followed by most of the mobile device manufacturers. This approach provides clearer, more precise and more variant information about the user's mobile device. It provides information about the connectivity capabilities of the device but this is still not enough for providing information about the connection bandwidth and the method of payment; whether the user is concerned about the connection time or the amount of delivered data.

In some cases, a simple software code could be applied in order to have a more precise value for some of these factors such as the connection speed.

But, for some of the factors there is currently no other way than asking the user to provide the factor, such as the Internet access method.

Module implementation

The implementation is realised as shown in Figure 2. The class evaluation module is integrated into the presentation tier of the system. It detects the device's capabilities and determines its class according the above described factors when the user connects to the system. However, the importances of such a single factor can vary dependant on the content (e.g. Text versus video). The Data Collection & Arrangement unit is only concerned about the resulting class in addition to the identifier of the requested page in order to perform its task.

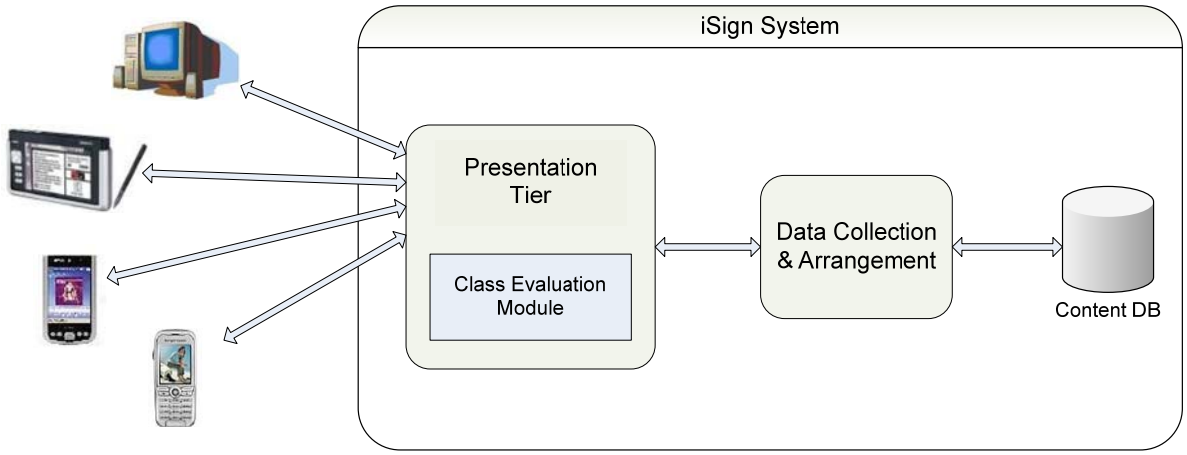

Figure 2: The iSign theory delivery subsystem

A combination of the determination methods which are mentioned before was used in the implementation of this module. The flowchart in Figure 3 models the whole process. First, it is detected whether the user is connecting to the system via a mobile device or a desktop device by analysing the user-agent header. Then, the visual factors are detected using the UAProf XML file which is downloaded from the manufacturer's server. The last step depends on the internet access method which must be delivered by the user.

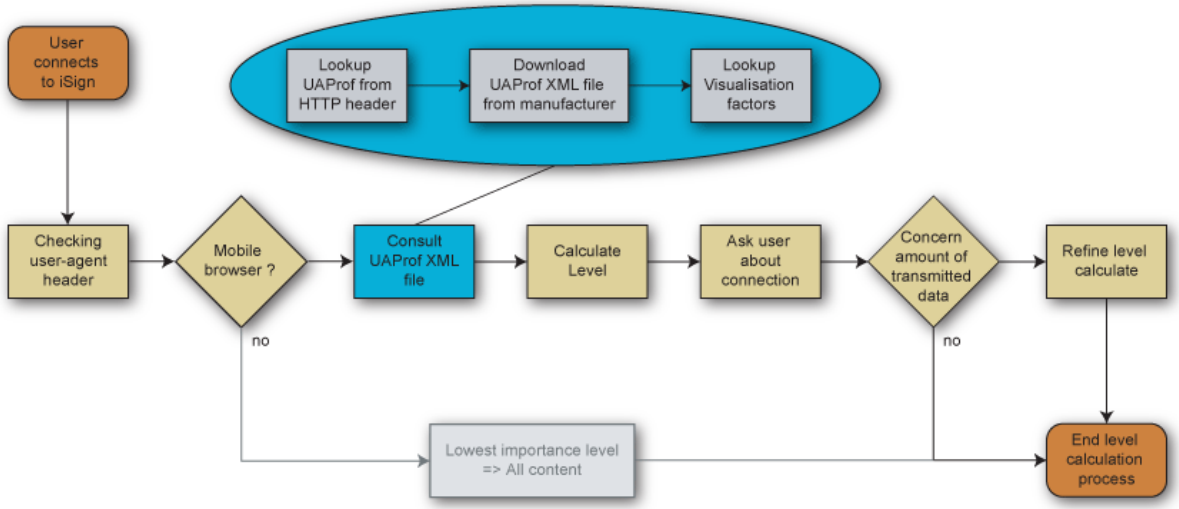

Figure 3: Class evaluation flowchart

XML data adaptation methods

The analysis of actual mobile device market studies has shown that all microbrowsers of the currently delivered mobile devices by the world wide market leaders fully support the WAP2.0 standard [8]. This implies the full support of XHTML MP (XHTML Mobile Profile), a subset of the XHTML markup language.

Our intention is, that all content is available as XML data (source data). The actually requested information can be selected individually depending of the request details. It forms a result set for the requesting user.

Only those content parts within the source data will be selected and provided as a result set which correspond to a predefined ***content class***. That is, according to the request details an appropriate class will be selected and consequently only those content parts, which belong to this class, will be inserted into the result set. Technically there has been carried out a mapping between request (details) and corresponding class.

The content class information has been realised by an additional attribute within all XML tags which are used as information source. It indicates to which class the content of the respective tag belongs. This ***class attribute*** is used when the content of the XML data is processed to dynamically form the result set (Figure 4).

The processing of the source data and transformation into two different result set formats (XHTML and PDF) is realised by the iSign system. Java code uses the instructions given by XSL file and processes the content of the source data accordingly. For each class there exist two XSL transformation files, one for XHTML and one for PDF output, respectively. The XSL transformation file that is used for the dynamic generation of PDF result sets contains instructions corresponding to XSL-FO. The XSL transformation file used for the generation of XHTML result sets contains pure XSLT instructions.

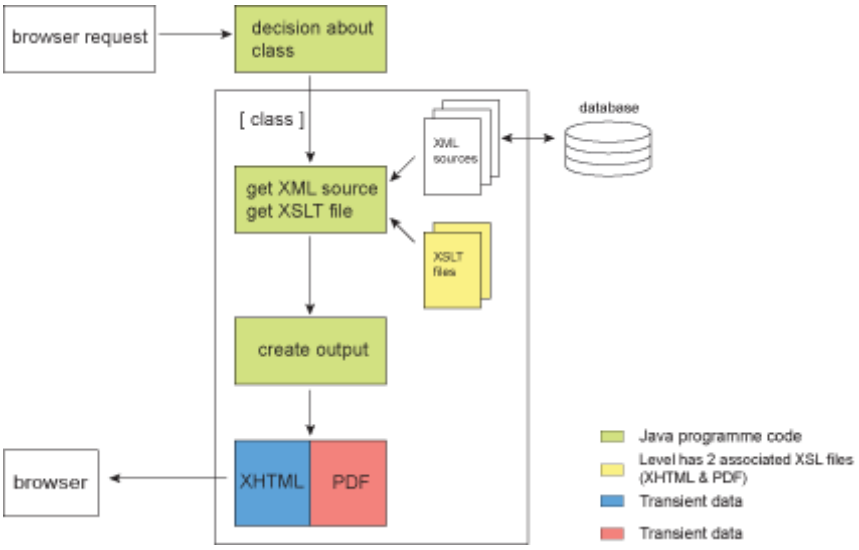

Figure 4: Dynamic creation of XHTML and PDF result sets

The benefits for the authoring process are:

- Use of XML format guarantees flexibility and portability of information.
- Only one additional attribute within XML tags - the class attribute – is necessary.
- The author is able to arrange the content in a hierarchical manner. Essential information is included in all the result sets, i.e. tagged with the content class that is always included in the result set. All supplementary information can be added incrementally using the other content classes until finally the content class is used that is only included for desktop systems which provides best conditions for displaying all information.

Design Patterns

The XML based data storage allows the authors to classify their content according to the importance of the content. Usually authors tend to generate their learning materials and later on strip it down to adjust the content to lower end devices. As result content can get incomprehensible and difficult to read and understand. Furthermore when cutting down content important relationships within the content might get lost and thereby also the information that is intended to be transmitted will be lost.

In this system contents which are less important can be omitted on lower end devices without loosing the learning contents. As a result of the studies and the development of this system it was found out that authors have to start with the ***essential*** learning content (Figure 5). This information has to be presented on all devices, whether the device is a mobile phone or a high end personal computer.

In the next steps the authors can add additional learning content. Every new added information has to be tagged and classified, whether the added information is ***important***,

relevant or ***optional***. In this way the authors ensure that the learning content on low end devices is still understandable because the ***essential*** content is transmitted. In order to avoid storage of the same content multiple times, a less important class contains always the information of all more important classes (e.g. Class relevant includes additionally content of important and essential).

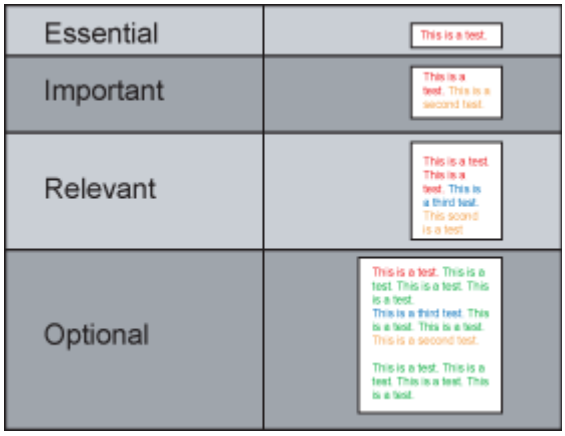

Figure 5: Content classes

The system decides which device fits best to an existing class and transfers the corresponding content. But the system does not automatically divide the content into different classes. This will and has to remain an author's task.

To categorise text into different classes is not a problematic task but it is time consuming. A problem can occur with other media formats like images, sounds and videos. It can not be guaranteed that all devices can present this media formats. As result this formats should be used with care especially if the importance of the learning content is high (as example ***essential*** content).

The best media solutions for images are media formats which are vector based and can be scaled without quality loss. Unfortunately such media formats are in most cases **not** supported by low end devices. In order to display such a media format on a low end device a media format conversion has to be performed at the server side. The output of such a conversion has to be a media format which is supported by the corresponding device (e.g. JPEG). Although a conversion has to be performed in order to present vector based media formats on most of the devices these formats are preferable. The reason is that these formats are scalable to fit optimal on the device screen without loss of quality.

In contrast to vector based formats, the pixel based can not be scaled without loss of quality. However scaling happens often on end devices in order to adjust the media to the screen. But scaling such materials can have dangerous side effects. For example small lines can disappear in a scaled down image. To avoid an unpredictable on device scaling, the format should be adequate “pre-scaled” by the system.

Conclusion and Future Work

The introduction of multiple XML based content classes and a corresponding classification of a connected device has increased the flexibility and adjustability of the system. However the authors effort to classify content in the actual state of the system requires a lot of technical knowledge and is time consuming. Further work will focus on simplifying the content creation and classification. Additionally, new developments will be studied and included in the existing system if of benefit. As example the W3C is currently working on a new markup language called DIAL (Device Independant Authoring Language) [7]. DIAL is based on XHTML, CSS and other W3C recommendations, but it also offers extra features which are aimed to make it easy to present content on a wide variety of mobile devices.

References

[1] W3C, (2004) “Composite Capability/Preference Profiles (CC/PP): Structure and Vocabularies 1.0” from: http://www.w3.org/TR/CCPP-struct-vocab

[2] W3C, (2006) “RDF Primer”, from: http://www.w3.org/TR/rdf-primer

[3] OMA, (2006) “White Paper on UAProf Best Practices Guide”, from: http://www.openmobilealliance.org/docs/OMA-WP-UAProf_Best_Practices_Guide-20060718-A.pdf

[4] M. Gaedke, M. Beigl, H-W Gellersen, C. Segor, (1998) “Web Content Delivery to Heterogeneous Mobile Platforms” University of Karlsruhe, Retrieved 11 1, 2006, from: http://www.teco.edu/~gaedke/paper/1998-lncs1552.pdf

[5] M. Ally, F. Lin, R. McGreal, B. Woo, (2005) “An Intelligent Agent for Adapting and Delivering Electronic Course Materials to Mobile Learners”, Retrieved 11 1, 2006, from: http://www.mlearn.org.za/CD/papers/Ally-an intelligent.pdf

[6] M. Feisst, D. Santos, J. Mitic, A. Christ, (2005) “Adaptive Heterogeneous Learning System” Retrieved 11 1, 2006, from: http://www.mlearn.org.za/CD/papers/Feist.pdf

[7] W3C, (2006) “DIAL Part 0: Primer“, Retrieved 11 1, 2006, from: http://www.w3.org/TR/dial-primer

[8] R. Omari, (2006) “A SW Module for Mobile Device Content Delivery”, Master Thesis, University of Applied Sciences Offenburg

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Experienced young PDA users set their own standards for m-learning

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Abstract

"Mr Flynn, I am getting better and better at using this PDA. Am I as good as you now?"

The Learning2go mobile learning project in Wolverhampton has involved over 1000 learners in 18 learning establishments across both primary and secondary phases. Since October 2005, learners have had their own PDA (personal digital assistant) to use both in school and beyond. They have used the device in a variety of exciting ways, including:

- receiving and learning from multi-media content
- browsing and researching from the Internet
- communicating their ideas
- authoring their own work using a variety of applications.

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 learner is responsible for managing their own device and helping to shape their own learning.

As the learners have had 100% access to the device during the course of this academic year, their m-learning capability has exceeded initial expectations. This short paper will describe how a group of experienced PDA learners, from several project schools, met to discuss, suggest and re-define how their progress in m-learning could be measured and recognised.

During the discussion session, children and teachers worked in partnership to describe 3 standards to which all learners should aspire. Learners were clear in their own mind what constituted a ‘good’ mobile learner across 5 categories of PDA use.

From these discussions, the ‘Loox Cool’ bronze, silver and gold awards were born. In this paper, the authors will share the process which resulted in the formation of these awards, blending m-learning and pupil voice.

Children’s experiences driving m-learning standards – are they not the best judge?

Experienced young PDA users set their own standards for m-learning

Introduction

Before September 2002, the concept of PDA's was an unknown quantity to much of the education sector in the UK. The overriding view seemed to be that a business person's tool, used predominantly to organise appointments and store contact details, had little role within the classroom. Were they not essentially a scaled-down version of the technology that already existed? Pocket Word, Pocket Excel – well known applications in mobile form. Why replace traditional pencil and paper methods with an electronic form which could be potentially unreliable? The adage "If it ain't broken, don't fix it!" seemed to encapsulate opinion.

Despite this mind-set, individuals within Wolverhampton, who were fast becoming immersed in the LA's progressive vision for ICT, saw the potential for mobile technology and mobile learning. And so with the help of David Whyley (Wolverhampton E-Learning Head teacher Consultant) and BECTA, twelve HP Ipaq devices were introduced into a Year 6 English group at Stow Heath Junior School, Wolverhampton. Wolverhampton is an urban conurbation in the industrial heartland of England, characterized by areas of severe deprivation, an ethnically diverse population and 'digital divide'.

In the first instance, the devices were still used as an authoring tool in the classroom; the children involved soon realised that they had ICT at their fingertips – they didn't have to wait until the whole class once weekly ICT lesson. Even at this early stage, the impact of these rather

‘basic’ devices was evident – increased motivation, engagement with learning, attendance and attainment. Was it pure co-incidence that all children involved achieved the highest level in their end of Key Stage assessment tests?

Even though the devices had had a fundamental effect on the children’s learning, the true potential of the handheld device was unlocked the following year by a 10 year old whilst watching a piece of multimedia courtesy of Espresso education. Her natural curiosity and inquisitive nature prompted her to ask the question – “Can I watch this piece of video on my PDA and take it home?” Her dumbfounded teacher could simply shrug his shoulders! Not content with this response, the child returned home that night and downloaded a free piece of software which enabled her to save and play her favourite video clip from Espresso on her return to school. This was truly the defining moment of the initial BECTA pilot project (BECTA/Perry 2003) – from this the notion of Learning2Go was born.

Development of the Learning2Go project

Over the next few months, lead by the vision of David Whyley, the project began to gather pace. Potential software partners were approached and convinced of the possibilities of multi-media rich handheld learning. In September 2004, Phase 1 of Learning2Go (Microsoft 2005) began in earnest – 120 Toshiba devices were placed in the hands of learners in two primary schools and two secondary schools. These devices differed profoundly from the original Ipaqs, both in design and in content, embodying the ethos that underpins the Learning2Go

project, namely using handheld computers to engage learners by delivering multimedia content, Internet and authoring tools to the palm of a learner's hand. Children had at their disposal multi-media software stored on an SD card, as well as a wireless and infra-red connectivity. True E-Learning began to unfold – children were using ICT as a tool to enhance and enrich their learning across all aspects of the curriculum. From research on the Internet to recording work using the video and stills camera, from downloading E-books to using interactive learning content, E-learning was now becoming a reality; seamless and almost second-nature use of technology, both in school and at home. Positive outcomes of Phase 1 were numerous – ICT skills exceeded expected National Curriculum levels, there was evidence of improved standards in other curriculum areas, children were beginning to become far more independent in their learning, aspirations, motivation and their own expectations were significantly raised and children were far more engaged in the learning process. As one child commented, "Our lessons are really good fun now."

Phase 2 of Learning2Go began with high expectations following the success of the first phase. 120 Toshiba devices in four learning establishments were scaled up to 1000 Fujitsu-Siemens Pocket Loox 720 devices in 18 establishments, including primary schools, secondary schools and a Pupil Referral Unit. Such an increase in number had training implications – one of the project's principal values is that the classroom practitioner is key to its success. Much time and money was invested in training staff in order that confidence levels were high.

Phase 2 saw a significant increase in collaboration with key software partners. The positive effects of a wide range of stimulating learning content and applications, coupled with

inventive cross-curricular teaching and learning opportunities, saw a dramatic increase in previously unseen and un-measured ICT knowledge and skills. Through observation and conversation, it was apparent that children had also formulated their own working definition of effective E-learning.

The "Loox Cool" award – children setting the standard for mobile learning

Assessment of primary school ICT has traditionally tended to focus predominantly on the acquisition and development of taught skills, learned via discreet ICT lessons. Levelled either against National Curriculum expectations or assessed against end of QCA unit criteria, such assessment rarely gives a true indication of the child's E-learning and by definition does not cater for the use of applications and skills developed through the use of handheld devices. In his evaluation of Phase 1 of Learning2Go, David Perry commented:

> *"Talking to these children, it is difficult not to be stunned at the adult way in which they use technical vocabulary, and this must represent a strong contribution to their ICT understanding."*
>
> David Perry – "I was Pants at IT" Sept 2005

The concept of assessing mobile learning was first prompted, quite rightly, by a child who asked, "How good am I at using my PDA?" The hesitation by an experienced member of staff when giving an appropriate response put the wheels in motion – how could we truly measure this new and previously unchartered learning?

Perhaps the most fundamental value of Learning2Go is that the child is central to their own learning. Children are perhaps the most significant partner – as commented earlier, their natural curiosity and appetite for multi-media learning has driven the project forward. In terms of assessing their newly acquired competencies, it was thought inappropriate that adults, who potentially knew far less about the devices, prescribe the criteria by which children would be measured. With this in mind, a select group of experienced handheld users were brought together, from a variety of schools. Their task - to devise a set of criteria, an award scheme, by which other users in the authority could be assessed.

Sponsored by the manufacturers of the current PDA device, the concept behind the "Loox Cool" award scheme were simple; firstly we wished to formulate criteria by which children and teachers could assess mobile learning competencies. Secondly, we wished to publicly reward children for their hard work and perseverance. Thirdly, we wanted the children to feel a real sense of ownership – an award system created by children, for children. And, if we are honest, we felt the children were far more knowledgeable about the functionality of the device than we were! Six experienced users, and two "new" users, were chosen from 4 schools from across Wolverhampton, their ages ranging from 10-16.

The award itself takes the form of gold, silver and bronze levels. For each there is a "Loox Cool" badge, coupled with tee-shirts. Our task as experienced users was to decide on the criteria which had to be fulfilled to achieve each level of competence.

The day itself began with a brief introduction from experienced lead teachers. Although the Learning2Go initiative promotes independence and children taking responsibility, it has become clear that the role of classroom practitioners is key. Deciding on key criteria for the award scheme was no different - our experience as lead teachers guided the children, clarified and channelled their thinking and discussion. The children were keen to firstly discuss and decide upon five key areas of PDA use which could be assessed. After lengthy debate, the following areas were agreed:

- device management
- use of multimedia
- use of the Internet
- use of E-books
- use of applications within the device.

For each area, children then put forward their ideas as to which skills might lend themselves to gold standard, which to silver and which to bronze. This particular discussion was fascinating to observe – experienced users of mixed age and gender, from across the city of Wolverhampton, engaging in articulate, collaborative, technical debate.

After much deliberation, an almost definitive list was drawn up for each award. The silver and bronze awards tend to focus predominantly on skill acquisition – as one child quite rightly commented, “You can’t really E-Learn with the PDAs if you don’t know how to use them.” The

children were keen to point out, for example, that beaming data via infra-red was a bronze standard skill, whereas swapping SD cards in order to exchange data was a skill required in the silver award.

The gold award has as its focus the notion of true E-Learning – combining using the device with cross-curricular learning skills such as decision making, independent thinking, collaboration and investigation. For example, whereas using one of the device's applications on its own might meet one of the criteria for bronze or silver, the children decided that combining applications to produce an end result, for example creating an "HLE project" (an application which allows the children to bring together a number of documents under on program to create their project) about a recent educational visit, was surely gold standard! These higher level skills are very much decision driven, with the child having to choose effective ways of using the device rather than being told what to do. The culmination of this day, followed by two day's follow up, was the creation of a list of criteria for each award – Gold, Silver and Bronze.

[INSERT FIGURE 1 ABOUT HERE]

Impact

Unbeknown to the children, much of what they described in terms of M and E-Learning ties in well with National Curriculum, and Wolverhampton's recently published "E-Strategy" (Wolverhampton 2006). Children involved in Learning2Go already see themselves as either being or having the potential to be true M and E- Learners. This is what National Curriculum ICT advocates – the use and application of taught skills in order that children become E-Learners. Through the "Loox Cool" award scheme, our PDA users can demonstrate their E-

Learning journey, culminating in them becoming true mobile E-Learners. And what has made the “Loox Cool” award scheme so refreshingly different is that it is the learners themselves who are leading the way forward.

[INSERT FIGURE 2 and 3 ABOUT HERE]

References

Becta (2003) / Perry. *Handheld Computers (PDA's) in schools Ref: BEC1-15081.* Retrieved November 14,2006, from http://www.learning2go.org/media/BECTA%20handhelds.pdf

Microsoft. (2005) *Wolverhampton City Council Mobilises Learning to Give Students Access to Anywhere, Anytime Education.* Retrieved November 14,2006 from http://www.microsoft.com/casestudies/casestudy.aspx?casestudyid=53880

Perry, D. (2005). *I was pants at IT.* Wolverhampton LEA 'Learning2Go' Mobile Learning-PDAs in Schools Project, Evaluation Phase 1 End of First Year Report August 2005, david perry associates. Retrieved November 14,2006, from http://www.learning2go.org/pages/download-area.php

Perry, D. (2006). *Harnessing technology in Wolverhampton* Wolverhampton Learning2Go Mobile Learning-PDAs in Schools Project, Initial Report Phase II report. January 2006, david perry associates. Retrieved November 14,2006, from http://www.learning2go.org/pages/download-area.php

Wolverhampton LA (2006) *e-strategy – Wolverhampton PDF* Retrieved November 14,2006, from http://www.learning2go.org/pages/download-area.php

Author Note

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Table 1

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Figure Captions

Figure 1. An example of Bronze award criteria

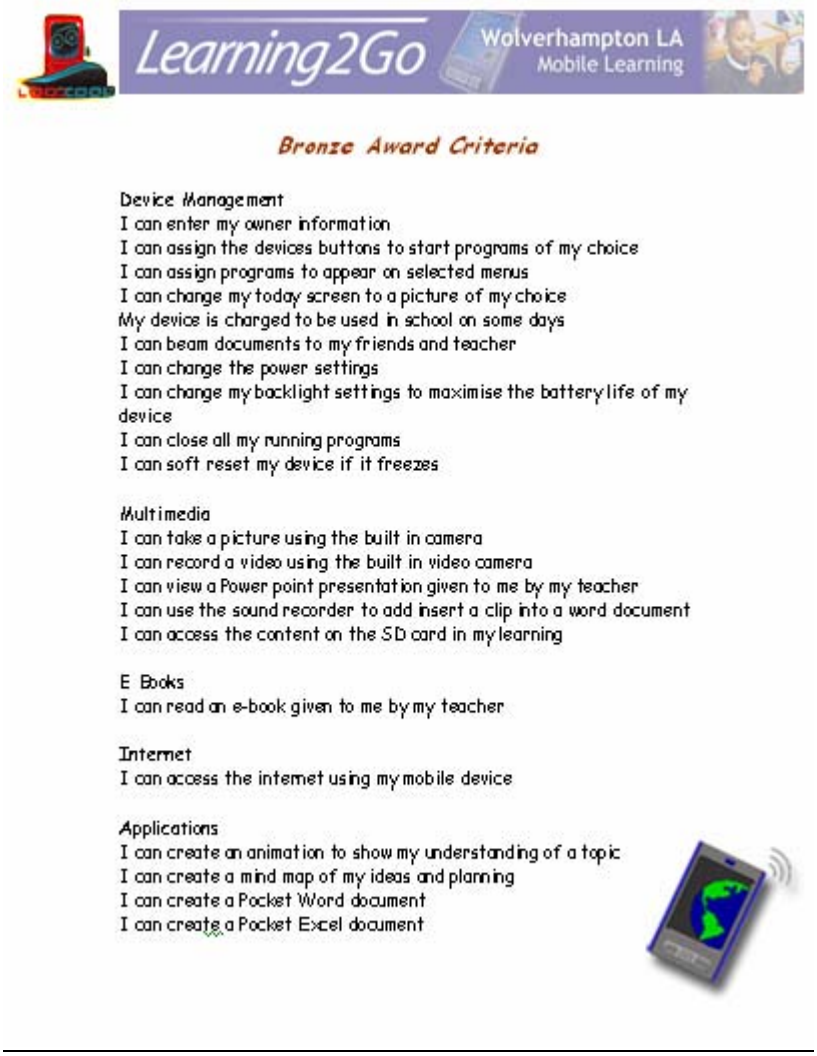

Figure 2 Loox Cool award badges and PDA

Figure 3 Loox Cool award winners presented with their awards, badges and t-shirts.

Running head: MOBILED – A MOBILE TOOLS AND SERVICES PLATFORM

MobilED – A Mobile Tools and Services Platform for Formal and Informal Learning

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October 22 – 25, 2006

Abstract

The MobilED initiative is aimed at designing teaching and learning environments that are meaningfully enhanced with mobile technologies and services.

The MobilED deliverables are to develop a set of scenarios and guidelines of how mobile technologies could be used for teaching, learning and empowerment of students within and outside the school context; a set of concepts and prototypes that will be developed into a MobilED platform that facilitates and supports the scenarios and guidelines developed and testing, evaluation, dissemination and sustainability strategies for the MobilED platform in real contexts with real people.

The first phase of the project included the design, development and piloting of a prototype platform where multimedia and language technologies (voice, text, images) are used via the mobile phone as tools in the learning process.

The first 2 pilots focused on the use of low-cost mobile phones, which are readily available in the developing world. It consisted of the development of a mobile audio-wikipedia, using SMS and text-to-speech technologies to enable access to information as well as the contribution of information using voice. The application was tested and results compared between a poor, rural school environment and an affluent private school environment in South Africa.

The second phase of the project looked at the use of more advanced mobile phones with multimedia capabilities. It consisted of a joint project between the “advantaged” and “disadvantaged” schools, called “Street Memory” which enabled learners to gather multimedia (sound, voice, video) information and make the results available to the community.

Pilots in South Africa are being replicated in Finland and will also be replicated in different developing world contexts in India and Brazil. MobilED will thus explore the cultural, social and organizational context of young people in and out of school in a developing world context (South Africa, India and Brazil) as well as in the developed world (Finland) in their utilisation of mobile phones in a learning environment.

The current principle partners of MobilED are the Meraka Institute of the CSIR, South Africa and the Media Lab of the University of Art and Design Helsinki, Finland. The network of associated partners and advisers includes the Centre for Research on Networked Learning and Knowledge Building, University of Helsinki (FI); Tshwane University of Technology (SA); University of Pretoria (SA); Escola do Futuro Universidade de São Paulo (BR); WikiMedia Foundation, (US) and the Center for Knowledge Societies (IN). Handsets were donated by Nokia and airtime was donated by MTN (South African network operator).

In this paper we will discuss the vision of MobilED, cover the role of mobile phones in young people's everyday knowledge acquisition and problem-solving situations, the applicability of this in an educational environment with a specific focus on the differences and similarities between the developing and developed worlds. We will present some of the concepts, prototypes and platforms developed in MobilED and discuss the results of the first tests carried out in formal school environments in South Africa.

MobilED – A Mobile Tools and Services Platform for Formal and Informal Learning

Mobile technologies, particularly the mobile phone, are set to have a major role in the development of the information society in developing countries. According to the International Telecommunications Union, Africa's mobile cellular growth rate has been the highest of any region over the past 5 years, averaging close to 60% year on year. The total number of mobile phone subscribers continent-wide at end 2004 was 76 million (ITU Report, 2006). The economic and social benefits of mobile phones are evident at all socio-economic levels of society and the penetration rate of mobile phones is significant, especially given the fact that access to these devices is often shared.

Deleted: to these devices

Contrary to trends in the developed world, where the PC and Internet-connectivity is almost ubiquitous, currently mobile phones are the most important networked knowledge exchange technology used in the developing world. From a developing country perspective, features such as limited or no dependence on permanent electricity supply, easy maintenance, easy to use audio and text interfaces, affordability and accessibility are the most important considerations for using mobile phones as potential learning tools (Masters, 2005; Mutula, 2002; Stone, Lynch, & Poole, 2003). The contention that a "socially and educationally responsible definition (of mobile learning) must view the learner as the one being mobile and not his/her devices" (Laouris & Eteokleous, 2005) and the ability for "anytime, anywhere" learning is still applicable in the developing world, but more as a positive side-effect. If we separate "mobile learning" into "mobile" and "learning", the "learning" aspect is the most important concept in the developing world. The computing device just happen to be mobile.

These mobile devices are becoming increasingly powerful computers, with built-in advanced multimedia facilities. It is interesting to note that today's high-end mobile phones have

the computing power of a mid-1990s PC— while consuming only one one-hundredth of the energy (Oelofse, 2006). Even the simplest, voice-only phones have more complex and powerful chips than the 1969 on-board computer that landed a spaceship on the moon" (Prensky, 2005). In addition, if we have a closer look at the whole mobile phone infrastructure we will realize that the actual device can be seen as a terminal for using several computers in a network. When making a simple call or sending a SMS message we use (1) the "computer" of the mobile phone, (2) server computers of the operators and (3) the "computer" of the receiver's mobile phone. When mobile phones are perceived as terminals for using computers we open up a new perspective for the design and development of practices on how mobile phones could be used in different human operations and processes, including formal and informal learning.

Context: ICT in Education in South Africa

South Africa's education system has undergone a dramatic change over the past 10 years, with the introduction of "Outcomes-Based Education" (OBE). Spady (1994) defines OBE as a "comprehensive approach to organizing and operating an education system that is focused on and defined by the successful demonstrations of learning sought from each student. Outcomes are clear learning results that we want students to demonstrate at the end of significant learning experiences and are actions and performances that embody and reflect learner competence in using content, information, ideas, and tools successfully." The South Africa education policy is thus one of the most forward-thinking in the world. However, the implementation of this policy has put tremendous pressures on the education system, and especially on teachers. This focus, combined with lack of infrastructure and insufficient funds have resulted in very little use of modern technologies in government schools in South Africa (Oelofse, 2006).

In order to drive a strategy for implementing ICTs in South African schools, the Department of Education published the national e-Education White Paper in November 2004. In this context, e-Education is defined as the use of ICTs to accelerate teaching and learning goals, particularly in a developing world context. ICT is seen as an enabler, rather than an end in itself. It enables teachers and learners to connect to better information, ideas and to one another via appropriate and effective combinations of pedagogy in support of learning goals (White Paper on e-Education, 2004.).

There has been a concerted attempt to introduce computer technology into schools within South Africa, with mixed results. Many have been PC-specific, sporadic and often adopt unsustainable models. Hence scalability is a major consideration. Issues that are prevalent include (White Paper on e-Education, 2004.):

- Lack of ICT-literacy at a general level amongst teachers.
- Stringent and structured forms of teaching with little or no scope for lateral thinking.
- Realization of the importance of technology but inability to incorporate this due to lack of training, adequate infrastructure and integration with the current curriculum. This is more apparent as we move from the urban to the rural centres.
- In most places there is a gender skew in access to education and this gets reflected in access to information technology.

Even in developed countries where computer technology has been used for educational purposes for several decades, the delivery has rarely met the expectation. Educators have used computers for drill and practice, automated tutoring and instruction and only lately as a tool for

communication, collaboration and problem solving (Statham & Torrell 1996). The use of technology or media in itself does not improve students learning achievements. Learning is more influenced by the instructional strategy than by the type of medium used (Clark 1985).

There is thus a desperate need for a new approach to integrating technology into the classroom, particularly in the developing world environment. The model needs to take into account issues of usability, accessibility and affordability whilst ensuring that appropriate pedagogical models are adhered to.

MobilED Philosophy and Principles

Currently mobile phones do not play an active role in formal education in South Africa. In fact, most schools ban the use of mobile phones during school hours. In an informal learning context, however, mobile phones are used widely. We call our colleagues and friends to seek information and reciprocally help them in their knowledge acquisition and problem-solving situations. Simultaneously, we build up our social networks and strengthen the links that are considered very important in modern theories of learning (e.g. Senge 1990). In African traditional culture **'Umuntu ngmuntu nga bantu'** means literally, 'a person is a person because of other people'. In other words, 'you are who you are because of others'. Expressed variously as **'Botho'** in Sotho and Tswana and **'Umbabtu'** in the Nguni languages, this concept is about a strong sense of community where people co-exist in a mutual supportive life-style.

The idea of the MobilED project is to create technology that supports existing social infrastructures; increases the potential of current practices with mobile phones by introducing new opportunities for knowledge sharing, community building and shared creation of knowledge in the authentic context of studying and learning. With this technology the participants may be

encouraged to increase the value of their current practices through knowledge sharing and collaboration across boundaries of time and place. Freedom from the constraints of time and place enable the timely use of technology wherever knowledge acquisition and problem-solving are situational and contextual.

The approach of the MobilED project is to integrate research-based ideas of using mobile technologies in teaching/learning with active scenarios of real learning programs. The project includes the design, development and piloting of prototype applications where multimedia and language technologies (voice, text, images) will be used via the mobile phone as tools in the learning process. In order to work within a contextual framework, the project will rely on the advances made in the psychology of learning, which emphasize the collective nature of human intellectual achievements and the use of the mother tongue in the learning process. The aim will be to enable all members of society (especially those in the developing world) to become active participants in the information society by being contributors and not just passive recipients of information.

From a technology perspective, all tools and platforms developed will be made available as Open Source Software (OSS), in support of the collaborative, knowledge-sharing philosophy of the project. Probably the most important benefit of OSS is that it stimulates the local IT sector in a country, which is crucial in developing countries to ensure full participation in the information society. From the social angle, OSS is highly beneficial because it allows software to be customised to local conditions by the communities themselves (Go OpenSource, 2006)

MobilED Objectives

The MobilED project has four key scientific, technical and developmental objectives:

- Explore and comprehend the cultural, social and organizational context of young people in and out of school in three developing countries (South Africa, India, Brazil) and in a developed country (Finland) in their utilisation of mobile technologies, particularly mobile phones.
- Develop research-based models and scenarios of how mobile technologies could be used for teaching, learning and empowerment of students within and outside the school context.
- Develop concepts, prototypes and platforms that will facilitate and support the models and scenarios developed.
- Test, evaluate and disseminate the scenarios, models, concepts, prototypes and platforms in the four countries.

The project aims to contribute to the scientific and technical know-how about how groups of young people in and out of school environments are using mobile devices in their everyday knowledge acquisition and problem-solving situations. It also aims to uncover user innovations and concepts around mobile devices through a participatory design process with users. Within the research work the project implements several prototypes that can be tested and disseminated in real environments, which includes schools, youth clubs and other informal groups.

Project participants

The current principle partners of MobilED are the Meraka Institute of the CSIR, South Africa and the Media Lab of the University of Art and Design Helsinki, Finland. The network of associated partners and advisers includes Nokia (Finland), the Centre for Research on Networked Learning and Knowledge Building, University of Helsinki (FI); Tshwane University of

Technology (SA); University of Pretoria (SA); Escola do Futuro Universidade de São Paulo (BR); WikiMedia Foundation, (US) and the Center for Knowledge Societies (IN). For the pilots, handsets were donated by Nokia and airtime was donated by MTN (South African network operator).

MobilED Research Framework and Process

The strength of the multi-disciplinary nature of the consortium as well as deep roots in cognitive, learning and design sciences lends a multi-pronged perspective to this initiative. In order to ensure cohesion and understanding between the different disciplines (which includes educators, educational researchers, educational psychologists, designers and technologists) a research framework was developed and is shown in Figure 1 below.

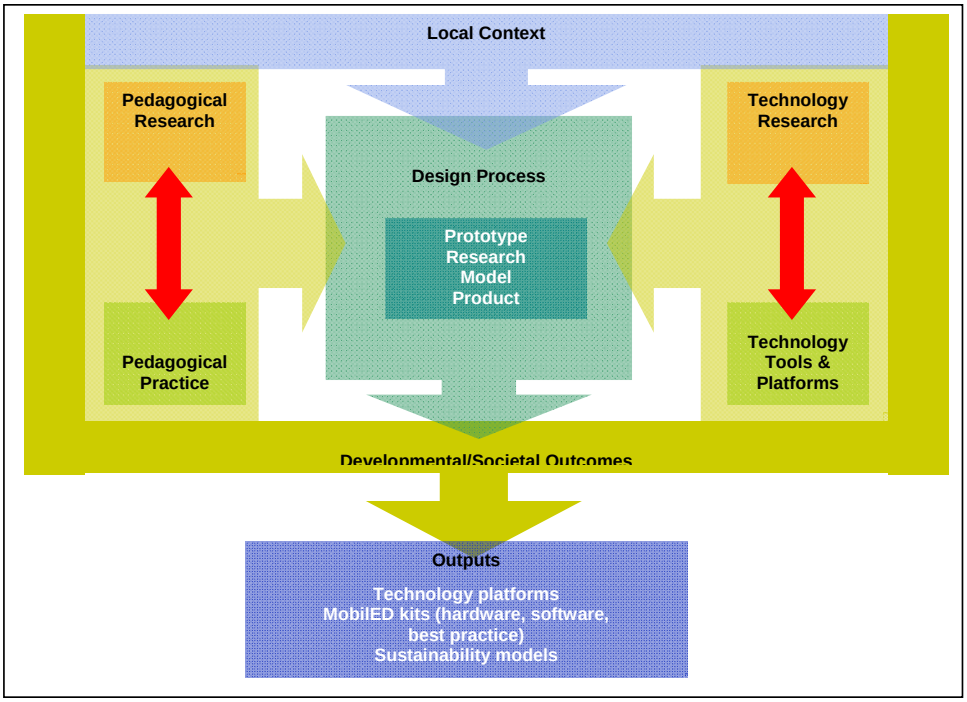

Figure1: MobilED research framework

Each intervention needs to grounded in the local context. Central to the intervention is the design process, which is fed by both the appropriate pedagogical models and the potential of the technology itself. Since South Africa is a developing country, any intervention needs to take cognizance of the developmental and societal outcomes. We are employing the *Outcome Mapping methodology* (as designed by IDRC in consultation with Dr Barry Kibel of the Pacific Institute for Research and Evaluation as an adaptation of the Outcome Engineering approach). This methodology looks at the results of an intervention as a behavioural change of project participants. Outcomes are seen as desired changes which indicate progress towards large scale development goals. At the heart of Outcome Mapping is documenting contribution rather than attribution; seeking to understand ways in which communities contribute to change rather than trying to attribute change to a single intervention (Smutylo, 2001).

Technology

The basic technology components that are used in the project are:

- Mobile devices and network(s): GSM/SMS phones, multimedia phones, Internet tablets, PDAs, the $100 laptop (OLPC project of MIT), etc.;
- Wikipedia: The Free Encyclopedia;
- Social Software: MediaWiki, blogs, knowledge building tools, etc.;
- Open Source Language technologies: Speech interfaces, audio usage, etc;
- Open Source telephony and software frameworks and platforms.

MobilED Pilots – 2006

The first phase of the project included the design, development and piloting of a prototype platform where multimedia and language technologies (voice, text, images) are used via the mobile phone as tools in the learning process. A scenario-based approach was taken to develop potential uses of the technology in formal learning environments. One of the main problems in South African schools is access to learning and reference materials for both learners and teachers. The focus was on how to use low-cost mobile phones, which are readily available in the developing world, whilst ensuring that participants not only access information, but contribute information as well. Based on these pre-requisites, we developed the concept of a mobile audio-wikipedia, using SMS and text-to-speech technologies to enable access to information as well as the contribution of information using voice. The mobile audio-wikipedia works as follows:

(1) A user can search for a term by sending a sms-message to the server,

(2) The server then calls the user, and

(3) A speech synthesizer will read the article found in the Wikipedia.

(4) If the term is not found in Wikipedia, then the user can contribute his/her story by dictating it to the system.

Prototype platform

Based on the scenarios developed, the technology development team built version 1 MobilEd platform. MobilEd employs three main technology platforms to achieve its goal:

- An SMS communication interface/gateway, such as Kannel (http://www.kannel.org) or Alamin (http://www.alamin.org/) to send and receive SMS's,
- the Asterisk Open Source PBX (http://www.asterisk.org/) for audio telephony communications, and
- a MediaWiki (http://www.mediawiki.org/) server with suitable content, such as en.wikipedia.org“ (Aucamp, 2006)

A typical high-level use case of the system is provided in Figure 2, below.

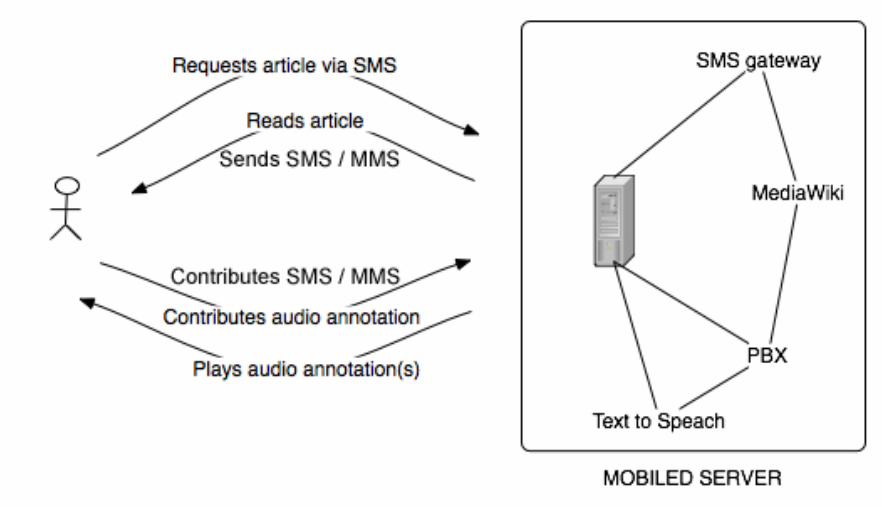

Figure 2. Simple high-level usage scenario (user's perspective). (Aucamp, 2006)

Comment [JC1]: reference

Pilot 1

The first pilot was conducted at a private school, Cornwall Hill College, in South Africa. The learners ranged from age 15 to 16. The theme of the pilot was HIV/AIDS. The project followed the principles of the Jigsaw cooperative learning technique (Aronson et.al, 1978),

where each learner is a member of two groups. The first kind of group is the “home group”, in our case we called them the “audiocasting groups” referring to the idea of podcasting. The second group is the “thematic expert groups”. Each thematic group consists of one member from each home group.

The thematic group discussed different aspects of HIV and used the MobilED server with the English Wikipedia content to search for information related to their theme.

Learners could navigate through the audio of the article as follows:

- “**Fast forward**”; skip ahead one sentence in the same section
- “**Rewind**”; skips back one sentence in the same section
- “**Next section**”; skips to the next section of the article
- “**Previous section**”; skips to the previous article section
- “**Pause**”; pauses playback - if any other DTMF key is then pressed, playback continues from where it was paused.

The photos below show examples of the instruction sheet and the use of the audio Wikipedia.

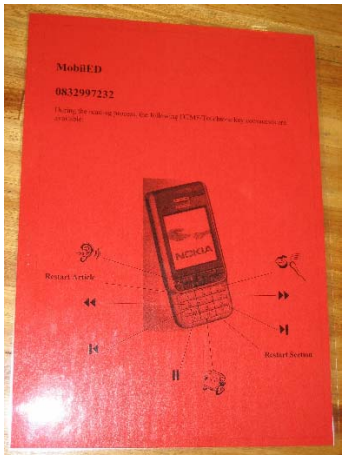

Figure 3: How to navigate the audio encyclopedia

Figure 4: Using the audio wikipedia

The results of the information retrieval and discussions were then reported back to each audiocasting group.

The audiocasting group then discussed the most relevant issues of HIV/AIDS for their own age groups and communicated the results to the school community as an audiocasting show that was recorded via MobilED onto the wiki. To access the audio encyclopedia and the audiocasting service, the students used shared Nokia 3230 phones with speakers.

The learners from Cornwall Hill College were all from affluent homes and most already owned a mobile phone. They were also fully ICT-literate. It was decided to test the service with these learners, before testing with learners from disadvantaged backgrounds, so that we could improve the platform based on their input.

The learners were given very little time to experiment with the phones before the pilot started, and although they supported each other and figured out all the main functions of the phones in a short period of time, they felt they needed more time to "play" with the devices. It was not necessary to "teach" the learners how to use a phone – it was an everyday skill that they had already mastered. In addition, these learners did not like the fact that the phones were shared in the group – each said they would have preferred their own phone. However, the use of shared phones with speakers supported collaboration towards the shared task. Based on the observation and the video data it was obvious that the use of the shared phone made it possible to distribute the cognitive load related to the use of the technology and to fulfill the study tasks and peer support and learning was obvious.

We also noted that the boys tended to "dominate" the technology usage. During the pilot there were a few technology "hiccups", and at one stage a temporary measure was instituted to

record their audiocasts onto an analog tape recorder – it was most interesting to note that more learners had more trouble figuring out how to use a tape recorder than using the MobilED service! Other input we received from these learners was that the "voice" used for the text-to-speech engine was very difficult to understand and that the speakers didn't work very well. Overall, however, there was overwhelming support and enthusiasm for (legally!) using their mobile phones in the classroom.

An unexpected consequence of the first pilot was that the school requested another pilot. Although this was not planned as part of the original intervention, an additional pilot (Pilot 1A) was run. In this pilot learners went on a trip to a theme park as part of a science lesson on energy. All interactions between the teachers and learners were via SMS. Some content was "seeded" on the wiki and the MobilED platform was expanded to include information retrieval via SMS as well. The learners used their own mobile phones and there was spontaneous sharing of mobile phone capabilities (such as photos, audio and video). Once again, there was much excitement and support for the concept by the learners (Botha et al, 2006).

Pilot 2

Pilot 2 was run at a local government (or previously disadvantaged) school, Irene Middle School. The learners were from very poor backgrounds and most travelled long distances from outlying rural areas on a daily basis to get school. Most learners did not own their own mobile phone, and many had never used a mobile phone. Although the school did have a computer lab, the computers had been stolen and the learners were not at all ICT-literate. The learners do not speak English as a home language, but are educated in English from Grade 4.

The MobilED platform was significantly enhanced and upgraded to version 2, based on the results of Pilots 1 and 1A. The Irene learners had a similar lesson on HIV/AIDS, based on the same lesson plans developed for Cornwall Hill College. The learners were given a longer period of time to familiarize themselves with the mobile phones and they were also given a printout of a typical Wikipedia article. Since very few articles exist on Wikipedia in their home languages (Sepedi, Setswana, isiZulu), the lesson was given in English. They were divided into groups as per the first pilot.

This MobilED pilot was once again a success, with wholehearted support from both learners and teachers. Learners were motivated and energized and clearly enjoyed the learning process. In fact, the server logs showed that many of the learners spontaneously used the service to find out information about many other topics (particularly World War 2 and Adolf Hitler, which was the current topic in their history lessons). Figures 5 and 6 below shows the groups "playing" with the mobile phone and accessing the MobilED service.

Figure 5. Trying out the MobilED service

Figure 6. Hard at "play".

Although the learners were not ICT-literate and very few had access to mobile phones, they took a very short time to familiarize themselves with the technology. Since many mobile

phones are shared in their culture, they did not have a problem with sharing the mobile phone during the lesson and enjoyed the collaborative aspects of the tasks. In addition, it was interesting to note that the boys did not dominate the technology as in the previous pilot – there was equal use by both sexes.

They were also less critical of the artificial voice (which had been improved in the interim). When asked about their language of choice for learning, every group chose English – they see English as the "academic" language and the gateway to opportunities later in life. It was interesting to note that interactions between participants were in their home languages, but most produced audiocasts in English. They were excited that their contributions could potentially reach a huge audience worldwide. It was obvious, though, that using English as the language of instruction was a major problem for some of the learners, as evidenced by the written responses to some of our questionnaires, which were in poor and broken English.

During this pilot there were very few technology problems and this contributed to a much better experience for these learners. The audiocasts were passionate and uninhibited and included spontaneous harmonizing of songs and rap songs. As part of the Outcomes Mapping methodology, some mobile phones were left at the school for the teachers and learners to use and we will be monitoring the use of the service over the next few months.

Pilot 3

In pilot 3 we wanted to observe the collaborative behaviour of groups of children from different cultural and socio-economic backgrounds when using the mobile phone as a tool for learning. We also wanted to introduce and test the use of MMS technology as part of the MobilED platform. Another aim was to test the platform with younger children. The first part

of the pilot in mid-October 2006, consisted of 10 learners (aged 13 – 14) from Irene Middle School and from Cornwall Hill College, who were invited to the Meraka Institute as part of a learning activity to create a re-usable multimedia slide show about 3 technology projects developed by the Institute. The following photo shows some of the learners who were involved in the pilot.

Figure 7. Learners from Cornwall Hill College and Irene Middle School.

The learners were divided into groups of 2 (1 learner from each school). An icebreaker activity was used to familiarise the learners with each other. Thereafter they were given a short period of time to "play" with the mobile phones and experiment with sending SMS and MMS messages. Their task was to use the mobile phone as follows:

- capturing information
- taking photos
- recording and storing

- compiling a slide presentation with all the above and MMS'ing to the server

The learners seemed to enjoy the activities and were extremely creative with their photographs. There was a marked difference at the beginning of the pilot with regard to usage of the mobile phones, but the less experienced learners soon "caught up" and were able to do most of the tasks with ease. Most pairs worked well in their groups, although there were instances of incompatibilities. As a whole the girls tended to work better in their groups and there was spontaneous sharing of knowledge in these pairs. This pilot is still incomplete and data is in the process of being analysed. The following figure shows the good spirit of cooperation that existed between the participants.

Figure 8. Collaboration and peer-learning.

Future

Over the next months, the MobilED consortium will be reflecting on the results of these pilots and will use the results to develop next year's strategy. Some of the ideas that have been touted in South Africa include:

1. Using the service to disseminate ideas and lesson plans to teachers, by creating slide shows of lessons with audio narrations in all 11 of South Africa's official

languages. A teacher could send an SMS with the title of the lesson to the server, and will be sent the slideshow (if they have an MMS-capable phone) or he/she will be phoned back and the audio played. The teacher could add an audio/video annotation to add his/her ideas to the lesson plan.

2. Making existing educational video/animation "bytes" available to teachers and learners via MMS and data services.

Interest in the project has been overwhelming worldwide. Brazil will start it's own MobilED pilots next year. Colombia and Mexico are also planning pilots. New Zealand is showing interest. For more information on the status of the project and future plans, the MobilED website – http://mobiled.uiah.fi, can be accessed.

The MobilED technology developed in the first year of the project (the mobile audio encyclopedia) has many different possible applications, beyond that of education. Since the basic content source is a wiki (in the pilots, specifically the Wikipedia implementation), this mobile audio wiki can be seen as a community information system that can be used with a mobile phone, of tremendous importance in places where there is a strong culture of mobile phones, but Internet and WWW are not widely used (Leinonen, Ratna Sari, Aucamp, 2006). Thus, the platform could be used for e-government, e-health, NGO support, SMME support, etc. in developing countries – all integral to socio-economic growth.

The MobilED platform not only enables all people in the developing world to access information, but to contribute information back – thus becoming active participants in the Information Society. It is making a significant step towards eradicating the Digital Divide.

References

Aronsen, E., Blaney, N.,Stephin, C., Sikes,J., & Snapp, M. (1978). The jigsaw classroom. Beverly Hills, CA: Sage Publishing Company.

Botha, A., Batchelor, J., Cronje, J., Aucamp, F. (2006). When wikis grow up and go for outings. Paper presented at mLearn 2006, the 5th World Conference on Mobile Learning, Banff, Canada.

Clark, R. E. (1985). Evidence for confounding in computer-based instruction studies: Analyzing the meta-analyses. Educational Communication and Technology Journal, 33, 249-262.

Goodman, J. (2005). Linking mobile phone ownership and use to social capital in rural South Africa and Tanzania. Retrieved March 9, 2005, from http://www.vodafone.com/assets/files/en/AIMP_09032005.pdf

ITU report (2006). [online]. What's the state of ICT access around the world? http://www.itu.int/newsroom/wtdc/2006/stats/index.html, Retrieved 12 October 2006.

Laouris, Y., Eteokleous, N., We need an educationally relevant definition of mobile learning. (2005). Paper presented at mLearn 2005, the 4th World Conference on Mobile Learning. Cape Town, South Africa.

Leinonen, T., Ratna Sari, E., Aucamp, F. (2006). Audio wiki for mobile communities – information systems for the rest of us. Paper presented at the Mobile HCI Conference.

Masters, K. (2005). Low-key m-learning: A realistic introduction of m-learning to developing countries. Paper presented at the Sixth Conference on Communications in the 21st Century: Seeing, Understanding, Learning in the Mobile Age, Budapest.

MediaWiki (2006). [online]. http://www.mediawiki.org, accessed 12 October 2006

Mutula, S. M. (2002). The cellular phone economy in the SADC region: Implications for

libraries. Online Information Review, 26(2), 79-91.

Oelofse, C., Cronje, J., de Jager, A., Ford, M. (2006). The digital profile of the teenage mobile phone user. Paper presented at mLearn 2006, the 5th World Conference on Mobile Learning, Banff, Canada.

Prensky, M. (2005). What can you learn from a cell phone? Innovate online magazine. (http://www.innovateonline.info/)

Senge, P.M (1990), The Fifth Discipline: The Art & Practice of The Learning Organization: Currency Doubleday, New York.

Smutyo, T. (2001). Crouching Impact, Hidden Attribution: Overcoming Threats to Learning in Development Programs. IDRC, Toronto, Canada.

Spady, W.G. (1994). Outcome-based education. Critical issues and answers. Arlington. American Association of School Administrators.

Statham, D., & Torrell, C. (1996). Computers in the classroom: The impact of technology on student learning. Boise, ID: Boise State University.

Stone, A., Lynch, K., & Poole, N. (2003). A case for using mobile internet and telephony to support community networks and networked learning in Tanzania. Paper presented at the ICOOL 2003 - International Conference on Online and Open Learning.

WikiPedia (2006). [online]. http://www.wikipedia.org, accessed 12 October 2006

EXPLORING THE CHALLENGES AND OPPORTUNITIES OF M-LEARNING WITHIN AN INTERNATIONAL DISTANCE EDUCATION PROGRAMME

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Imagine you are a student, studying as a postgraduate on a distance learning Masters course, offered by a UK institution. You are based in a developing country in Africa, employed full time, and due to the nature of your work in the development sector you often have to make trips to rural areas, and are sometimes away for more than a month at a time. You have a good job, but your disposable income is limited as you have a lot of financial commitments and a young family. You live in a society where livelihoods depend amongst other things on transport, livestock and communication, and where the price of a cell phone is equivalent to a cycle, a cow or three goats. What kind of learning resources and tutorial support would you consider suited your lifestyle and study preferences best ?

For many years, answering this type of question has been constrained to consideration of options revolving around printed study resources, and written assignments submitted to tutors who provide feedback. Over the last decade email has transformed communication, and a lot of consideration has also been given to the use of the Internet and Online Learning Environments. However, access to the Internet as a platform for learning, has remained limited in Africa due to lack of infrastructure, together with reliability, affordability and performance issues.

The big growth trend, over the last five years, has been the rapid and very widespread diffusion of mobile phones. Admittedly the functionality of the phones currently used revolves around text and voice. However, looking forward to three years time, and considering the powerful range of functions that newer phones with General Packet Radio Service (GPRS) and 3rd Generation (3G) functionality possess, we can explore the question raised at the start of this article afresh, as these devices increasingly support use of text, graphics, audio, video and interactive content.

This paper provides a description of the experience of the first year of a two year project titled 'Developing an educational model for delivery and support of postgraduate distance learning in Southern Africa that incorporates M-Learning'. The project is funded through a grant from University of London Centre for Distance Education (CDE), and is being implemented by Imperial College London Distance Learning Programme (DLP) with support from University of Pretoria's Department of Educational Innovation (EI).

The paper focuses on three main aspects of the work done so far:

i) Results from a baseline survey carried out with the DLPs students in the Southern African Development Community (SADC) countries.
ii) Lessons learned from the first year, relating to the project context and student profile.
iii) Preliminary steps taken to design and test practical and educational activities, that aim to make use of mobile phones to add value to the educational experience of the students.

The Baseline

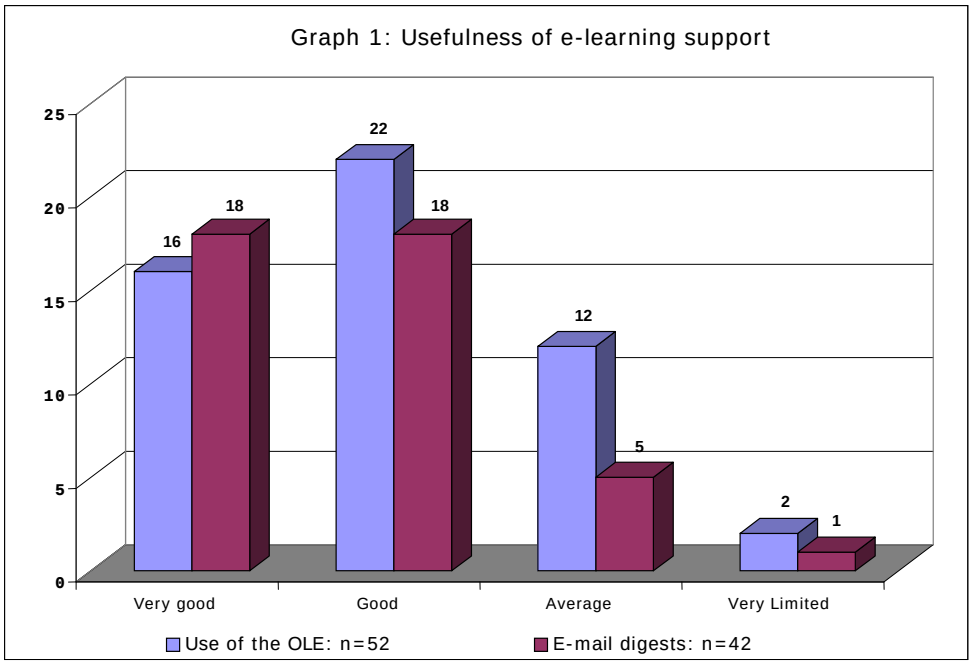
The DLP currently supports 88 Commonwealth Scholarship students pursuing postgraduate Masters level distance learning courses (See Table below). These students are based in Commonwealth countries within the SADC region. In order to improve support to these students, the DLP has worked in collaboration with the University of Pretoria's Department of Agricultural Economics and Department of Educational Innovation (EI) since 2002.

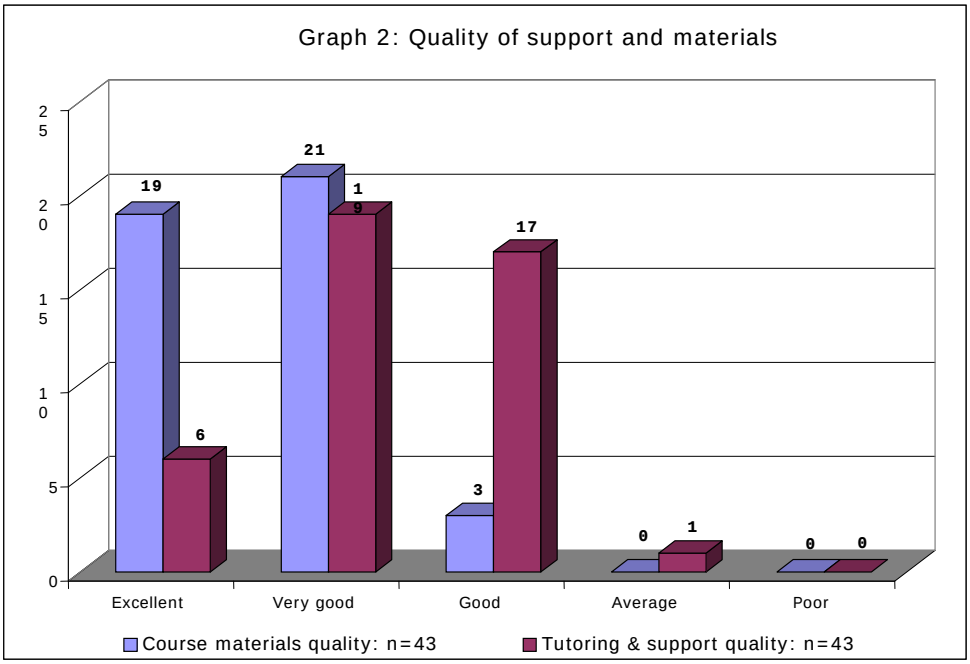
SADC Student Numbers in 2006

Country		*Msc Programme*	*SADC Student Nos*
Botswana	12	Agribusiness for development	9
Lesotho	3	Agricultural Economics	5
Malawi	13	Applied Environmental Economics	1
Mauritius	9	Biodiversity Conservation and Management	10
Mozambique	2	Environmental Management	13
Namibia	7	Food Industry Management and Marketing	1
South Africa	7	Managing Rural Change/Development	18
Swaziland	4	Sustainable Agriculture and Rural Development	17
Tanzania	15	Sustainable Development	14
Zimbabwe	7		
Zambia	9		

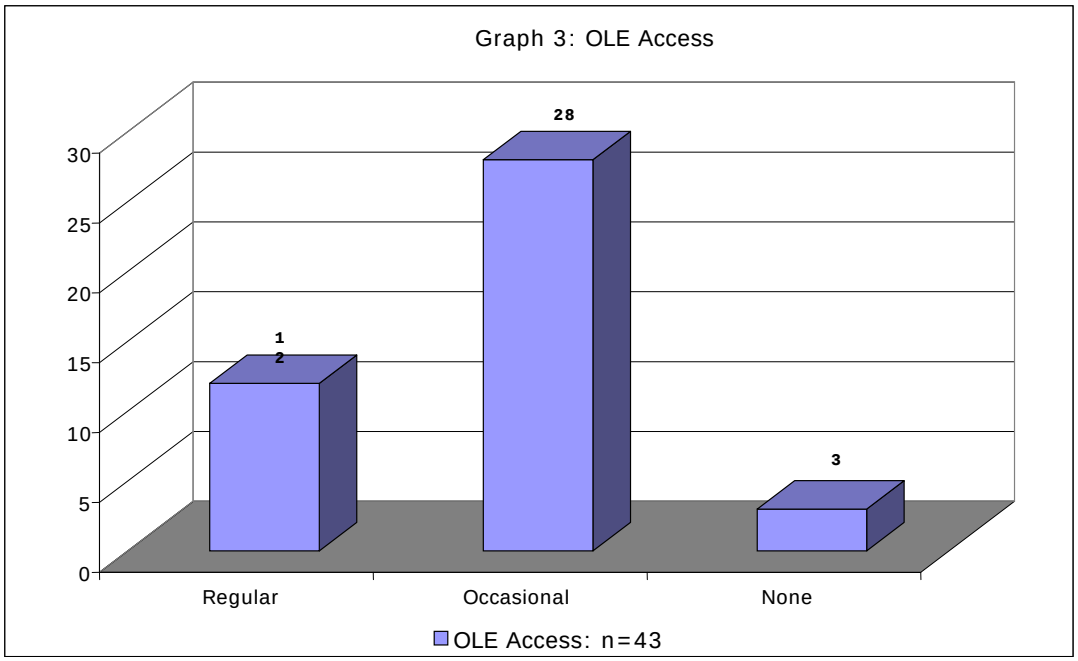
DLP students are typically mid career professionals, with more than 75% between 30 and 50 years old and approximately one third are female. On registration they receive a study pack comprising a study guide, copyright cleared reading materials and possibly an audio or video cassette and relevant software. This pack contains everything they need to study a module, and over the last three years the DLP has begun to produce interactive CD-ROM based versions of modules containing a study guide and further study resources. Tutoring originally centred around providing feedback to students who submit optional Tutor Marked Assignments (TMAs), either through the post or by email (n.b. the majority of students have access to email). For several years an Online Learning Environment (OLE) has been provided as a base for group discussion and interaction with tutors, and to improve inclusivity and access to discussions a recent enhancement has been provision of regular tutor e–digests that reflect of student questions and course content.

In March 2006 a baseline survey was conducted with these students, and there were 43 responses. The graphs that follow illustrate the respondents' ratings for the current e-learning approaches:





Whilst these responses are encouraging, the constraint on OLE access (illustrated below) was regarded as a problem, and several in-country tutorials were organised to overcome this limitation. These workshops were rated as useful, but many students found it difficult to get time off to attend, or too expensive to travel to a workshop location. This type of event is also very expensive to organise.



The table below shows the access that the respondents have to different types of technology and application:

Computer	At Home **24**	At Work **40**	No Access **0**	
CD ROM Drive	Yes **41**	No **1**	N/A **1**	
Cell Phone	Personal **38**	Provided by Employer **11**	No Access **1**	
Internet	At Home **8**	At Work **38**	Cyber café **18**	No Access **1**
Email access	Regular **37**	Occasional **6**	No **0**	

These responses are unlikely to be typical of the whole survey group, since survey responses were sent in by email. The respondents generally also rated themselves highly in relation to their level of ICT literacy (‘very good’ (16), ‘good’ (21) and average (6)). Computer and internet access are most likely to be via the workplace, and yet by contrast most indicated that they study mainly ‘at home’, followed by ‘in the office’, and least when they are ‘away on field work’. The amount of time spent out of the office was significant, with 18 respondents indicating that they spend 1-3 months per annum in the field, and 13 indicating that they spend more than 3 months.

All respondents indicated that they used their phones for receiving voice calls and almost all sent and received text messages. Interestingly a lower proportion (70%) made voice calls. The amount of money spent each month was also revealing as it varied from $4 to $100 per month.

The survey details summarised so far, suggest that there is a potential role for use of mobile phones to support learning, since almost all respondents have them, and they offer the only technology that could potentially be used ‘anytime, anyplace’.

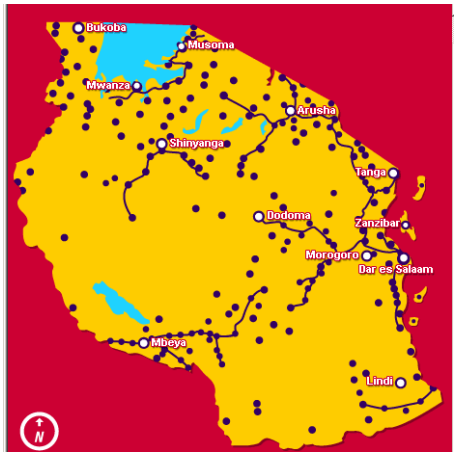
Lessons learned from the context

After reviewing relevant literature on mobile learning projects, the project has focussed on understanding the context and student profile, and determining which mobile technologies should be considered.

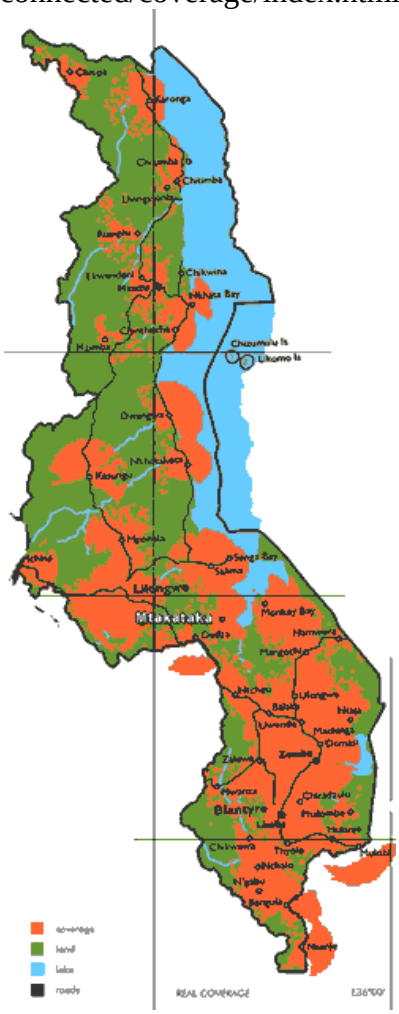
The context of the distance learner is highly important, as is the need to understand how they work and study. In developing countries, a student may for example study whilst travelling on a bus to the field or by candlelight when there is a power cut. Political disturbances may disrupt communications. Appropriateness of technology needs to be considered with an appreciation of such factors.

Mobile coverage maps were reviewed for all countries in SADC, and it was noted that there was reasonable coverage in most SADC countries particularly in major cities and towns, and on major routes. Significant demand for coverage in villages and rural areas was noted, driven by people wanting to 'call in' as well as 'call out'.

Four students were selected to be involved with the project in the first year, as this is sufficient to enable us to obtain qualitative feedback. Students were selected based on location, mobile coverage availability, module studied and progression within the MSc programme (i.e. they should be in year two or beyond), and gender. One male and one female student were selected from Tanzania and two male students from Malawi. Three students are based in major towns and one in a rural area, near Dwanga in Malawi.



Celtel Coverage Map for Tanzania
http://www.tz.celtel.com/en/get-connected/coverage/index.html



Telekom Coverage Map for Malawi
http://www.telekom.co.mw/COVERAGE.html

The modules that the students were studying were reviewed, and two modules were selected for the focus of the project. These modules are 'Rural Development' and 'ICT for Development'. During the course of the project, new content and activities designed specifically to run or support mobile technology will be developed and tested, and in 2007 the tutors on these two modules will also become directly involved.

Visits were made to Malawi and Tanzania in February 2006, to find out more about local ICT trends, and explore the realities, constraints and possibilities of the context where the students were based.

The students were interviewed and videoed, and audio versions of the interviews have been shared amongst the four students, so that they are familiar with each others' context and suggestions. These interviews provided a rich picture of how students use their current phones, computers and the Internet, and how they prefer to study. Personal factors such as wanting to keep on existing phone networks, or keep an existing phone number were identified, and initial suggestions about how a mobile device could support learning were explored. It became clear that in three out of four cases the students selected had reasonably good access to Internet, and the fourth student could access e-mail on an occasional basis. It was also clear that the students travel a lot locally and sometimes internationally, and mobility is therefore an important factor to be considered during the pilot project and in scaling up mobile learning support to the wider student community.

The main cell phone operators offering services in the countries selected are shown in the table below:

Malawi	*Tanzania*
CelTel	CelTel
Malawi Telekon	Tigo (formerly Mobitel)
	Vodacom
	Buzz

Meetings were held with CelTel and Vodacom in Tanzania, and it became clear that plans to roll out 3G networks are moving ahead quickly. GPRS services are becoming widely available supporting data services, including multimedia and MMS applications. The price of GPRS services remains high: for example in Tanzania 1 kilobyte of data costs Tsh 50 which is the same as the cost of sending a text message. Significant usage of GPRS services at this stage is therefore not realistic for students, and transfer of large files between students and the DLP will be best done via transfer to a PC and email or internet services. Operators did sell phones, but handsets tend to be sold separate from usage contracts, and are similar in price to SIM free handsets purchased in the UK.

Mobile phone services fall into three main groupings:

i. Basic level services: voice call and text messaging
ii. GPRS services: transfer of data and multimedia on an asynchronous basis
iii. 3G services: real time video calls

Handsets typically have features that are designed to operate well at one of these levels, and students surveyed currently make use of basic level services. The four students helping with the project were given the activity of finding out about available phones and suggesting which services could be used for this phase of the project. The activity made use of their existing phone models, and a combination of e-mail and SMS, confirming our ability to communicate with the students in these ways.

It became clear that rather than proliferating devices, a mobile phone with smartphone capabilities (that support GPRS and potentially 3G services) was preferable to a PDA. Whilst both can be synchronised with a PC and have multiple functionality, the phones were generally smaller and more portable, had better video and image capture, sound and communication capalities, and offered more scope to explore both learning content and tutoring and administrative support. Both had capability for storage expansion. PDAs typically benefited from larger screens and more practical keypads, and sometimes more powerful applications. The added value of mobile phones for learning was more oriented to multimedia than to input or reading of lengthy text.

The model chosen by the students (shown opposite) is the Nokia N70 (local cost TSh 570,000) supplied with a 1Gb storage card, and Bluetooth connectivity. Its capabilities included:

- Audio recording and playing of compressed sound files (i.e. supporting podcasting approaches)
- Contact management, calendar and to-do list
- SMS and Multimedia Messaging
- Application viewers for pdf, word, excel and PowerPoint files
- Two cameras for video and still images
- Powerful PC based software for management of files between PC and phone, and software on the phone that can powerfully link personal media to a ‘typepad’ blogging website

The model selected can be purchased and maintained locally, but transferring money and arranging contracts locally was problematic, so it was decided to supply phones from the UK, although this may not be practical in any future scaling up of activities. The phones (with a monthly credit allowance transferred to the student to encourage usage) were supplied to the students in exchange for a commitment to support the project research activities. Through the provision of a specific model we have better control over the variables which may influence the use of mobile device and can therefore concentrate on the appropriate and effective educational use of the device.

The opportunity arose to deliver the phones personally to the two students in Tanzania and show them how to use different features. By contrast the phones were sent by DHL to students in Malawi. This has allowed us to contrast the two groups, and determine the extent to which

training makes a difference. So far, both groups are progressing well, and we are exploring ways in which students can help each other as they encounter problems.

A wide range of practical issues have arisen during the period that flag up important concerns to be considered further in any scaling up of the project to a larger group of students. The SADC students' survey identified and ranked problems faced when making use of a mobile phone as follows:

1. Cost	2. Coverage	3. Theft
4. Reliability	5. Damage	6. Power supply

The list below identifies other challenges and issues, relevant to any scaling up of activities, that were identified as the context was explored in more depth:

- **Phone Supply**: whether to supply a specific handset to students, or support a wide range of models that students have, provided they meet minimum specifications
- **Insurance**: difficulties in arranging in country cover
- **Import duty**: an issue if the phone is supplied
- **Supporting usage**: since use of phones is expensive, there is a real issue in determining the most affordable ways to offer mobile support to the learners, and this is likely to complement rather than replace current e-learning strategies
- **Technical set-up:** setting up connectivity e.g. between phone and computer, and using Bluetooth, typically requires support
- **Network and Service Coverage**: This is changing fast, and whilst it is not practical to use GPRS for much of the pilot testing, the context in 2-3 years, may make use of GPRS or even 3G a more realistic prospect
- **Power Supply:** recharging phone batteries is an issue when students are working in rural areas
- **Online Content:** WAP currently provides access to low bandwidth websites on older phone models, but over the next 2-3 years, use of phone browsers using HTML/WML or java applications is likely to increase

Preliminary steps relating to design of activities

The project is now entering a key phase, where activities are being developed (i) for testing out the ability of the students to use different functions of the mobile phone and exchange data with the DLP; and (ii) to enhance the module learning materials.

The phone usage tests are nearly complete and are proving that students are capable of using the different functions of the phone, and transferring audio, image and video files back and forth from the phone and exchanging them with the DLP and fellow students via the Internet.

One question the project team faced from the outset, was whether the content of a module could be used in entirety on the mobile phone, or whether the phone should simply be used to support improved communication for administration and tutoring. In order to address this question and explore where value can be added from an educational perspective, a range of activities are now

being developed for the two modules selected. These activities will make use of the multimedia and communication capabilities of the phones, and include testing the following:

- Learning activities, and assignments, that encourage students to make use of their phone's multimedia capabilities, and submit short videos, audio files and images back to the DLP
- The potential for supporting groups working on activities together
- Improved interaction between tutor and student, for example by making simple multimedia versions of e-digests
- Redesign of content, so that it is less dependent on text, so for example interviews with experts and tutors, or use of short interactive content, can replace written explanations of concepts that can be delivered better using multimedia

The activities will be evaluated by students and tutors during the 2007 academic year, and a small database is being set up that will document and profile the outcomes, and provide a reference for answering the following questions:

- What kind of learning objectives, and pedagogical approach is the activity suitable for?
- Are there specific technical pre-requisites that need to be met in order to make use of the activity, e.g. file types, network services
- Were any relevant constraints identified when testing the activity in Tanzania and Malawi?
- How is the activity best delivered to the student ?
- How was the activity designed, and what resources were required ?
- How was the activity evaluated ?
- What were the student and tutor reactions to this activity when it was tested ?

The project team are also testing different models of phone including the i-mate Jasjar, k-jam, Nokia E61 and N80, to gain further insights into the type of equipment and features that might best support module content and activities. It has also been interesting to note and evaluate the ways in which software supplied with different mobile phones is now integrating with online weblogging sites.

In this phase of the project, there will also be a detailed look at the type of support environment that would be need by users of mobile technology. This environment could provide a platform for content sharing, and potentially benefit from a standards based learning object repository designed for mobile technology users.

Based on the insights gained so far, it is clear that there is great scope for building an inclusive learning community in a much more personal way than is possible using the OLE. There are many challenges to consider in scaling up to providing mobile support to students in diverse locations, and from an educational perspective there is significant potential for engaging learners interactively with learning resources that make greater use of multimedia and adapt to different learning styles and lifestyles.

Bibliography

B'Far, R. and Fielding, R. (2004). Mobile Computing Principles: Designing and Developing Mobile Applications using UML and XML, Cambridge University Press

IDRC (2005) Acacia Project Atlas: Mapping African ICT Growth, http://www.idrc.ca/acacia/ (accessed 30 September 2006)

Jones, M and Marsden, G (2005). Mobile Interaction Design, John Wiley and Sons

Kukulska-Hulme, A. and Traxler, J. (2005) Mobile Learning: A handbook for educators and trainers, Routledge Farmer

Pashtan, A. (2005). Mobile Web Services, Cambridge University Press

UNDP (2005) Human Development Report 2005, http://hdr.undp.org/reports/global/2005/ (accessed 30 September 2006)

‘My grandfather is dead’: narratives of culture and curriculum

Elizabeth Hartnell-Young, Frank Vetere

Introduction

Curriculum, the term used to denote a course of study, has been understood in recent years as a documented program developed by experts and managed by an education authority. In many cases this has resulted in a focus on the experience and the goals of dominant cultures, so that minority groups do not feel well-represented in the curriculum. In this paper we explore the possibility of young people using mobile devices to enrich their curriculum by contributing content that encapsulates aspects of their lives.

In a short project, we provided indigenous secondary school students from both urban and isolated communities in the Northern Territory of Australia with camera phones, and, in conjunction with their teachers, encouraged them to freely record and reflect on aspects of their lives. We found that they created artefacts of personal and cultural identity, and in some cases, extended digital narratives, of which they were clearly proud.

Background

Our view of learning draws on Dewey (1910), who saw it as the process people engage in when constructing knowledge rather than the transmission of information from those who have it to those who do not. Learning is however, mediated by both tools and people (Vygotsky, 1978). With regard to technology, Roschelle (2003) suggests that we should identify the simple things that technology does well, and understand the social practices by which these things become powerful education interventions. Similarly, Heppell argues that while mobile phone technology is important, what matters most is what students and teachers can do with it (Cole, 2003). We see a continuum of user activity from consumption of digital material via the Internet and mobile delivery methods; through reproduction, such as compiling a digital presentation from other sources; to creation, such as making new digital products (Hartnell-Young & Vetere, 2005). We believe that creating content plays an important part in learning, and that mobile tools are particularly useful in supporting creation, in the style of ‘citizen journalism’. They allow for situated learning, where people make meaning as a product of activity and the culture and context in which that activity occurs (Lave & Wenger, 1994). Learners can engage in and capture both planned and unplanned experiences, so that their activities have an authenticity that takes into account the social and historical context (Brown & Duguid, 1996). Their experience becomes part of their curriculum. Learners can gain knowledge and skills, and feeling a sense of agency in the world.

Perspectives on curriculum have shifted over recent centuries. Goodson (1994) traces the shift from a respect for learners’ life experience, incorporating a two-way conversation between teachers/elders and learners, to a paradigm of control of knowledge, and the use of curriculum as a mechanism to differentiate between people. Andy Hargreaves (1994) argues that the content and categories are a powerful device of social selection and social control: in terms of gender and race, and also social class.

As a result of legislation designed to enshrine people's right to education, formal schooling became associated with a repression or denial of the life experience of many pupils as expressed in dialect or in traditional cultural forms. Increasingly, nations document detailed curricula that teachers must implement and be accountable for. Some critics argue that such documented curriculum frameworks allow teachers (and thereby students) little control over the content (Cuban, 1984; De Marrais & LeCompte, 1999), while others see them as flexible design spaces that can be filled with a wide range of learning activities that teachers and students devise together (Hill & Russell, 1999; Petraglia, 1998; Scardamalia & Bereiter, 1999). We take the view that the many activities of teachers and students could contribute to a curriculum for building knowledge.

Accompanying recent trends to formalise curricula is the concern, in some countries, that learning should be 'personalised' (D. Hargreaves, 2004). However it is argued that many young people already have highly personalised digital experience, not adequately acknowledged in formal school settings (Green, Facer, Rudd, Dillon and Humphreys, 2005). Their report contains a Learner's Charter 'that includes the words 'to be supported to co-design my own curriculum and learning goals'. In this context, some see new technologies as a means of personalising learning using individualised devices, crossing boundaries between in-school and out-of-school time, and valuing the content and life experience that learners choose to share through telecommunications, blogs and social networking software. Berth (2006) suggests that, based on her research with young people, incorporating everyday technologies in the curriculum can transcend any distinction between formal and informal learning.

We suggest that a broad view of curriculum would acknowledge and value these aspects of learners' experiences. However, the ability to capture everyday activities both purposefully and opportunistically has led to vast stores of digital fragments. In our previous work with people using mobile devices, we have observed their attempts to make order out of collections of fragments. Evidence of everyday activities may not be immediately useful but could well have merit as a reminder or for its educational or evocative qualities (Marshall & Jones, 2006). Marshall and Jones (2006) discuss how activities such as associating material with a particular taxonomy and establishing a stable sense of place are important for sense-making.

Narratives are a form through which people understand their world, at least in part (Bruner, 1991;Mateas & Sengers, 2003). By creating stories around phenomena, we make sense of experiences and are able to recount them to others. According to Plummer (2001), it is only through narratives that memories exist, and without narratives we lose connection to who we are and where we have come from. Narratives integrate fragmented artefacts into a whole, giving a temporal context. Eggins and Slade (1997) suggest four categories of storytelling texts: anecdote, exemplum, recount and narrative, following Plum (1988). As their focus was on conversation, they did not address visual media, as we attempt to do in this paper. Narrative, they say, involves complication followed by resolution. An anecdote is a story that builds up some disturbance, followed by a reaction. Exemplums have an explicit message on how the world should or should not be: what matters is the significance of the events in the context of culture in which the story is told. Recounts simply involve retelling events, in a time sequence, without a crisis or climax.

We believe that mobile devices as particularly useful in supporting the creation and sharing of knowledge, and in creating digital stories, and we explored this with indigenous young people in Australia, whose culture has been passed down through oral narratives. An English term–song lines–has been used to describe the 'maps written in songs, depicting mythic events along a trail that winds through a region, singing the world into existence' (Chatwin, 1988). Recently new media have been used to capture the stories. A recent movie, Ten Canoes, was made in a local aboriginal language, by a cast made up mainly of untrained actors. The director has said 'The mob in Ramingining has embraced it as their true story. It is for them to show their children where they come from and where their ancestors come from. For the rest of the world it's got to be an entertainment and a journey into a world you've never been before' (de Heer in Kuipers, 2006). As many young indigenous people are keen to use new technologies, it seemed appropriate to involve them in our research.

Rationale and Method

In 2004, when Nokia announced their Lifeblog software, we recognised the possibility of using the software to capture and organise fragments of evidence of everyday life as well as school experience, and conducted a pilot study with individuals and families in a range of settings (Hartnell-Young and Vetere). In addition, one of the authors was managing a national project in boys' education in Australia, which addressed particular concerns about indigenous learners and the capacity of information and communications technologies to engage boys in learning. It seemed appropriate to allocate part of our ongoing work with mobile phones to a small project in this area. Nokia (Finland) had provided us with 1 megapixel camera phones (model 7610) running Lifeblog software. The software automatically stored text, images and video including SMS and MMS, and sorted this collection of material chronologically in the Timeline feature. Editing software enabled users to modify images and video clips (the muvee feature).

The emphasis on time supports a storytelling form. Photographs and videos could be easily labelled easily, and annotated with separate text notes. Synchronising the phone with a PC enables the material to be saved into the computer's Lifeblog software, where the view stretched seamlessly along the Timeline. We hypothesised that the organising capacities of the software, and the opportunity for reflection, could also make it useful for learning.

With the support of two schools in the Northern Territory, we provided one camera phone with Lifeblog software to each of five indigenous students, four of them boys. This demographic group often displays low literacy scores, irregular school attendance, and a high proportion of discipline incidents in school. After discussions with teachers who believed that the students would benefit from using the devices, we left them and their teachers to make the decisions about how to use them, and returned several weeks later to see what they had done.

The participants were all secondary school students, one from an island community who attended boarding school in Darwin, a female boarder from a remote community in another state, and the others from the urban area. Table 1 shows some characteristics of the students. They used the phones at home and school, but rarely took them out on Friday nights, for fear of theft. A teacher in each school took a light-

handed approach to supporting the students with technical requirements, such as with connection to suitable PCs, as none of the students had a computer at home. We asked that participants share the material in their Lifeblog with us at several points in time, and visited each student at least once at their school for a face to face discussion about the material, which we recorded and transcribed. One student's phone was stolen when she returned to her home town.

Student A	Student B	Student C	Student D
Male, urban	Male, urban	Male, remote (islands)	Female, remote (interstate)
14 years old	13 years old	17 years old	17 years old
Little phone use; rare computer use	Little phone use; rare computer use	Pre-paid mobile; no email	Some mobile and email use. Phone stolen early in project

Table 1. Participants in the Lifeblog project

Our approach adapted the 'cultural probes' techniques developed by (Gaver, Dunne, & Pacenti, 1999), extended by contextual interviews (Beyer & Holtzblatt, 1998). In this case, we used the handset as the probe, using it to capture information about the life of our participants. The context was sometimes quite formal, being in school, and as far as possible, the researchers used the same tools as the participants. We assured them they could delete items that they did not wish to share with us, and following this, they normally saved their Data Store (as Lifeblog calls it) to a CD or DVD and sent it to us. In this way we collected 4 separate Lifeblogs, each spanning several weeks, which we reconstituted in Lifeblog on our own computers and analysed in the following ways.

We looked at the Timeline feature, containing items that spanned the period of use, and categorised the form of items (image, SMS, MMS, video, text note, etc). We then considered the content of the images, notes and so on. We noted, for example, whether the images were of school, home, leisure, friends or family. Finally, we looked for storytelling forms, both across a set of items, or within an item, particularly in the video clips.

Findings

We found that the students treated the devices as a precious gift, and took great care of them. They created many videos, photographs, and used the image editing tools to provide context for the movies and stills. They also used SMS communication frequently, and downloads from Internet containing sports scores and video clips. Family and friends were the dominant themes in the material they shared with us, in the contexts of home and school. In this section, we look closely at the Lifeblogs of three of the students

Student A was a 14 year old who was often in trouble at school, and had previously been suspended for four weeks for bullying. He was considered at risk of dropping out. He enjoyed rugby and heavy metal music, and working part-time in a restaurant. He had previously used a mobile phone occasionally, only starting to text family and

friends a few months previously. Most of his text messages were about football. Once he received the phone, a teacher met regularly with him and a small group, with the intention of using the text features to improve their writing skills.

Figure 1 shows a screenshot from Student A's Lifeblog, annotated by us. It includes seventeen images, and one videoclip that had been imported into Lifeblog's 'muvee' feature. The accompanying text note reads 'This is a film of my friend shem I 'd film him then went to menu then movie then quick muvee and select a title and that's how I made a film (sic)' and is clearly prompted by his teacher.

We have circled three images that captured images of object (such as a CD cover) that appealed to him. All the other images are of family and friends. There is little evidence of narrative in this collection, though he was able to recount stories prompted by the images.

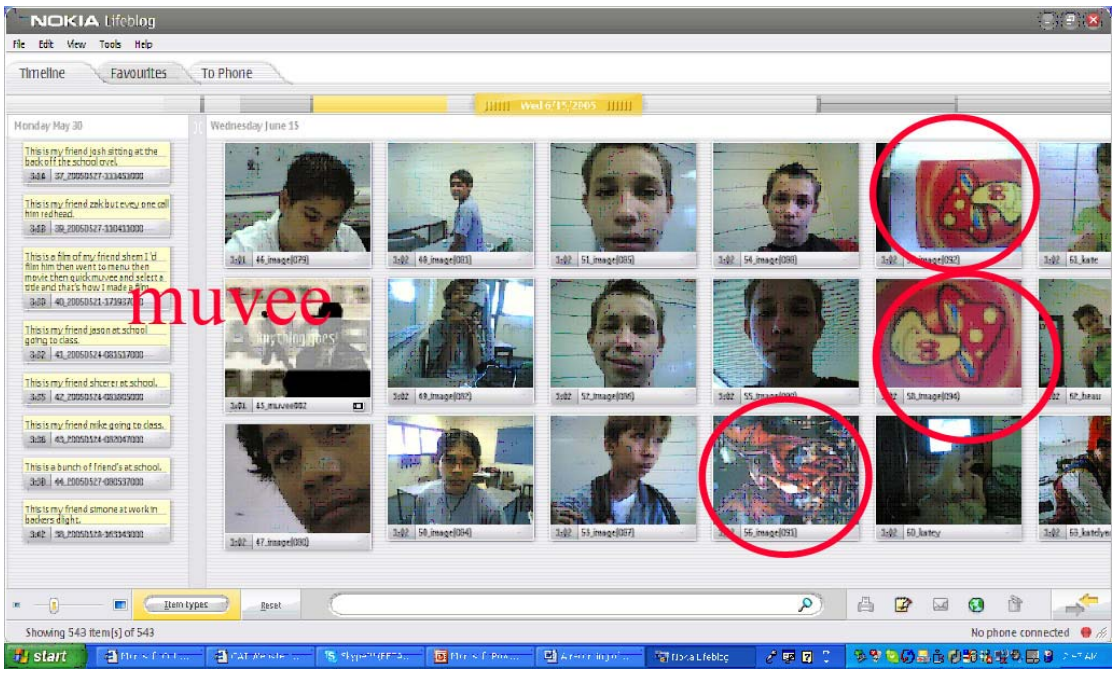


Figure 1: Lifeblog screenshot: Student A

In other parts of his Lifeblog, Student A included videos made at home, including family members. He told us 'This is my brother. I haven't seen him for while. And this is a movie of my little brother.' His text notes tended to be simple descriptors such as 'This is me holding my baby ness (niece)' and 'This is my favourite heavy metal call pantera.' Many of these movies could be construed as anecdotes of life at home. They included characterisation and were aesthetically pleasing, although of poorer quality than from a dedicated camera. This student (and most others we met) however, was not concerned with the quality, but with the emotion captured in his clips.

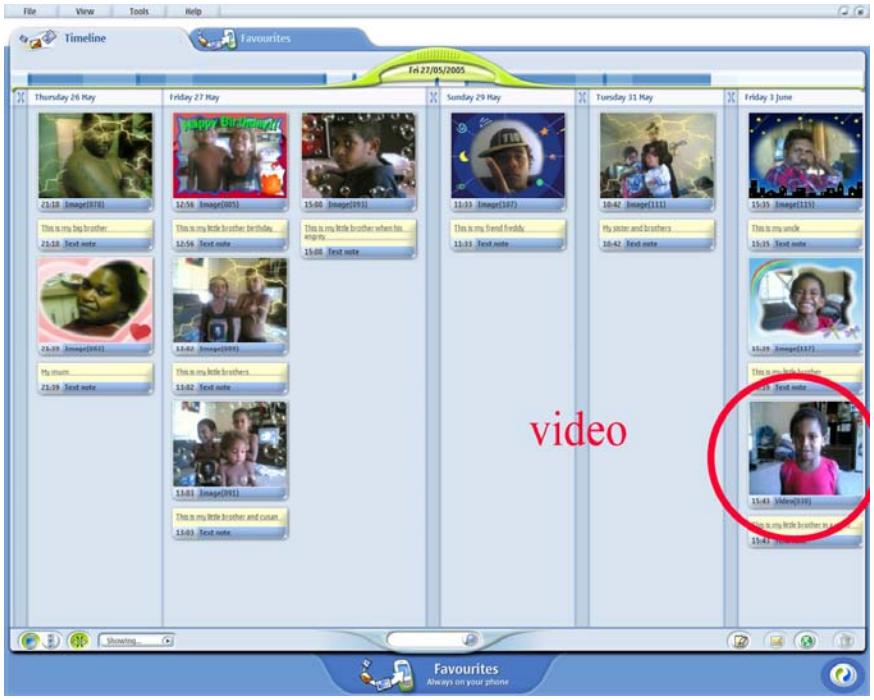


Figure 2: Collection of items in Timeline: Student B

Student B used his Lifeblog a little differently. Figure 2 shows a Timeline of items, containing ten images, one video clip, and eleven text notes, one describing the content of each item. In every case but one, the images are of family members. This student imported all his images into the image editing software on the phone. For example, he surrounded a photo of his mother with a pink heart, and one of his uncle with a city skyline. We suggest that the choices made in presenting the images indicate an early level of storytelling. It appears, for instance, that he associated his mother with love.

The video of his little brother (lower right in Figure 2) captured several attempts at singing the ABC song right through, with encouragement from his mother, who was holding the camera phone. Eventually the little boy managed to sing from A to Z and in tune! This clearly was an anecdote in Plum's (1988) terms. When shown to an audience later, it evoked involvement (will the little boy get to Z without faltering?) and a reaction of relief and some amusement when he did. A second video starring the little boy (partly shown in Figure 3) featured a toy motor bike, and was clearly a narrative of fantasy.

Figure 3: Motor bike narrative: Student B

Another video in his Lifeblog showed several brothers at home in their kitchen. The camera lingered on an older brother's interesting tattoo, (also captured in the top left image in Figure 2). To write a text note about this, he stopped the video at the point where he could clearly read the tattoo, and then wrote 'nagibu its my granfathers name he died when i was little (sic)'.

Student C began by taking images and videos around his boarding school, as shown in Figure 4, a screenshot that includes 3 video clips. (He did not adjust the date on his phone, so it appears as 01 January). He also used the phone for Internet connections and music downloads.

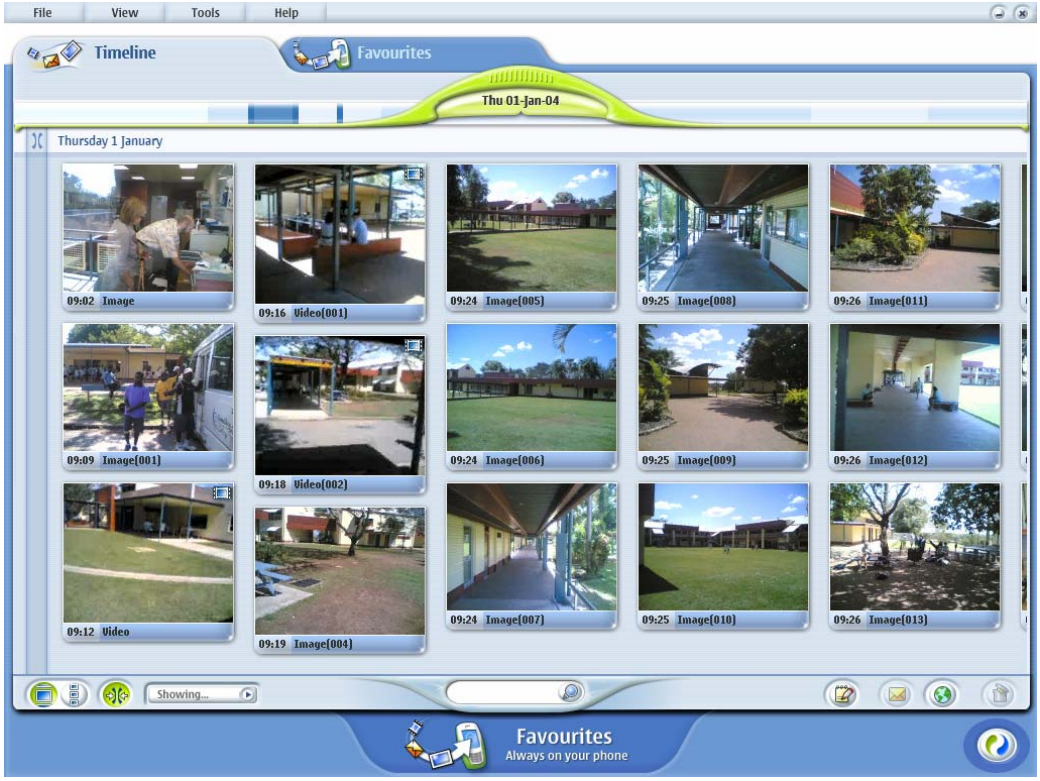


Figure 4: Early Lifeblog of Student C

However it was when he returned to his island community for the school holidays that this student took advantage of the camera phone to capture aspects of his rich cultural heritage, one based on oral and visual–rather than written–history. He told us that he used to buy a throwaway camera when he went home to the islands, and found the camera phone met his needs very well. In addition to writing down these stories at school, he made video clips, including stories told by his elders in the indigenous language, and was proud of the way he could continue the storytelling tradition in a digital form. It took him some time to get used to movie making on the phone, he said, as he had only used a phone to ring up people before. However his island did not have a telecommunications network, so his focus was filming daily life in the island community. Extended clips showed young people playing 'water polo' in the river, a group of youths on a lively trip in a minibus along a dusty road, and a very amusing story of a snake that escaped. Stills from the video are shown in Figure 5.

Figure 5: Still images from video of escaping snake: Student C

As he later described the scene to us, he and his friends had been hunting in the bush, and had 'whacked the python on the head a couple of times'. They were then trying to 'boil him up'. The snake woke up and climbed out of the pot, so they were chasing

him around. Not only is this a rich recount, when shared with an audience back at school it becomes a powerful window into the life of a student from an island community. Such recounts can inform the curriculum.

A final example from Student C shows how deep meaning can be supported by devices such as these camera phones. This was a sombre video recording of his grandmother singing, by a campfire, of his ancestor who had survived the white people's massacre of the indigenous community on the Tiwi Islands. This is clearly a narrative, telling how the old man hid inside a crocodile nest to escape the fire in the bushes, and how later, when he emerged, he was given a new name by the white men. This family song has been handed down through the generations, and Student C used the recording to help him learn the song because, as he told us, he is 'one of the next leaders'. When he grows up and sings this song it is his duty to teach his kids, so he said he 'had to learn it correctly'. He told us: 'My grandfather is dead. I know the stories and it's my responsibility to keep it strong.' This is both narrative and exemplum, rooted in the culture, and passing it on.

By giving these students a status item, and, perhaps, by valuing their everyday life in the school context, our small project appeared to increase their self-esteem, so that taking the phones back was more of an issue in this case that in other parts of our Lifeblog project. Although participants had been told throughout that this was to be the case, it was an ethical problem that we and at least one teacher had to grapple with.

Conclusions

Through this project, we saw the beginnings of various forms of storytelling facilitated by the mobile devices. We suggest that learning can be personalised by listening to students through such digital creations. There is potential for crossing boundaries between home and school though using technologies that belong in both environments, enabling students to contribute their life experience to the school curriculum.

If this is to occur, teachers will play a key role, and their attitudes need to be understood if mobile devices and the content created by students are to be valued in learning. Many authors (eg. Hannafin and Savenye, 1993) have noted the importance of teachers in introducing new technologies into learning. In this study we worked with teachers who volunteered to be involved, alleviating the problem of resistance. The teacher who met each week with the small group of students including students A and B encouraged them to bring evidence of their family life into the school via their mobile phones. Further, he encouraged them to reflect, albeit at a simple level, on the images and video, and to write simple sentences to describe them. This was an additional activity designed to increase the boys' engagement in school, and was not formally assessed as part of the curriculum, although there is clearly potential for this to occur, in a framework of digital literacies. Other teachers in this school allowed the phones in class, but did not incorporate them into lessons. In the boarding school, the teacher had a close relationship with Student C, and provided an enthusiastic audience for his created content, linking it with essay-writing and other assessed tasks.

We concluded that the mobile devices and digital content can be important tools in producing narratives of everyday life and recording culture. They require both action and reflection and thus can contribute to learning. In a longer project, with more time to make connections with learning and with a means of assessing the digital content, it seems possible that real learning gains could be made. As a result of this work, we intend to continue research into how mobile devices support learning, using narratives to organise and make sense of personally-created information. To do this, we will work with teachers in considering new areas of curriculum and assessment.

References

Berth, M. (2006). *Informal learning with mobile devices: moblogging as learning resource?* Paper presented at the Informal Learning and Digital Media Conference. Odense, Denmark.

Beyer, H., & Holtzblatt, K. (1998). *Contextual Design: Defining Customer-Centred System*. San Francisco: Morgan Kaufmann.

Brown, J., Collins, A., & Duguid, P. (1989). Situated Cognition and the culture of learning. *Educational Researcher, 18*(1), 32-42.

Brown, J., & Duguid, P. (1996). Stolen Knowledge. In H. McLellan (Ed.), *Situated Learning Perspectives* (pp. 47-56). Englewood Cliffs, NJ: Educational Technology Publications.

Bruner, J. (1991). The Narrative Construction of Reality. *Critical Inquiry, 18*(1), 1-21.

Carroll, R. (2006). Mobile Learning and Assessment Project (unpublished report). Chisholm Institute.

Chatwin, B. (1988). The Songlines. Melbourne: Penguin.

Cole, G. (2003, January 7). Ring tone revolution. *The Guardian*.

Cuban, L. (1984). *How teachers taught: Conspiracy and change in America's classrooms 1890-1970*.New York: Longman.

Cuttance, P., & Innovation and Best Practice Consortium. (2001). *School innovation: Pathway to the knowledge society*. Canberra: Department of Education, Training and Youth Affairs.

De Marrais, K., & LeCompte, M. (1999). *The way schools work: A social analysis of education* (3 ed.). New York: Longman.

Dewey, J. (1910). *How We Think*. Boston: Heath and Co.

Eggins, S. & Slade, D. (1997). *Analysing Casual Conversation.* London: Equinox.

Gaver, B., Dunne, T., & Pacenti, E. (1999). Design: Cultural Probes. *Interactions, 6*(1).

Gibbons, A.S. (2006). The interplay of learning objects and design architectures. *Educational Technology*. Jan-Feb 2006. 18-21.

Goodson, I. (1994). *Studying Curriculum*. Buckingham: Open University Press.

Green, H., Facer, K., Rudd, T., Dillon, P., & Humphreys, P. (2005). *Personalisation and Digital Technologies*. Bristol: NESTA Futurelab. Retrieved 14 November, 2006, from http://www.futurelab.org.uk/research/personalisation/report_01.htm

Hannafin, R., & Savenye, W. (1993). Technology in the Classroom: The Teacher's New Role and Resistance to IT. *Educational Technology, 33*(6), 26-31.

Hargreaves, A. (1994). Critical Introduction. In I. Goodson, *Studying Curriculum* (pp. 1-11). Buckingham: Open University Press.

Hartnell-Young, E., & Vetere, F. (2005). *Lifeblog: A new concept in Mobile Learning?* Paper presented at the IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE) Tokushima, Japan.

Hill, P., & Russell, V. J. (1999). Systemic, Whole-school Reform of the Middle Years of Schooling. In R. Bosker, B. Creemers & S. Stringfield (Eds.), *Enhancing Educational Excellence, Equity and Efficiency* (pp. 167-196). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Kuipers, R. (2006). Rolf de Heer. In *The Australian Way* (Qantas Airways Ltd). August. pp 6-7.

Lave, J., & Wenger, E. (1994). *Situated Learning: Legitimate Peripheral Participation*. Cambridge: Cambridge University Press.

Mateas, M., & Sengers, P. (2003). *Narrative Intelligence*. Amsterdam: John Benjamins.

Petraglia, J. (1998). The real world on a short leash: The (mis)application of constructivism to the design of educational technology. *Educational Technology Research and Development, 46*(3), 53-65.

Plum, G.A. (1988). Types of spoken narrative. Paper presented at the LERN conference: Working with Genre. University of Technology, Sydney.

Plummer, K. (2001). *Documents of Life 2: An Invitation to Critical Humanism*. London: Sage.

Nokia. (2006). New Nokia Lifeblog - the photo diary that writes itself. Retrieved 30 March, 2006, from http://www.nokia.co.uk/nokia/0,,28358,00.html?press_release_id=http://press.nokia.com/PR/200603/1038181.xml

Roschelle, J. (2003). Unlocking the learning value of mobile phones. *Journal of Computer Assisted Learning, 19*(3), 260-272.

Scardamalia, M., & Bereiter, C. (1999). Schools as knowledge building organizations. In D. Keating & C. Hertzman (Eds.), *Developmental health and the wealth of nations: Social, biological and educational dynamics* (pp. 274-289). New York: The Guildford Press.

Vygotsky, L. (1978). Mind in Society: The Development of Higher Psychological Processes. Cambridge, MA: Harvard University Press.

Walker, K. (2006). Narrative and Mobile Learning in Practice and Theory.

Where is the “m” in Skills for Life?

Bob Harrison

Paper on the fly M Learn 2006, Banff, Alberta, Canada.

There are changes afoot in the world of Skills for Life. The post-Moser “golden era” in which the teaching of literacy and numeracy moved from the shadows into the spotlight may be about to shift focus. Is there still a place for innovative and challenging approaches to learning in the skills for life field? To put it another way, can we afford not to experiment and explore as targets become more challenging and learners harder to reach?

Current policy initiatives in Skills for Life are revealing a trend towards the functional. The 14-19 Education and Skills White Paper, for example, shows the DfES giving the QCA a remit to develop functional skills in English, Mathematics and ICT “to engage purposefully as citizens and in employment”. Another trend is the apparent focus on Level 3 qualifications, with less of an emphasis on Entry level learners. ICT is still considered to be important: 21st Century Skills: Realising our potential highlights the importance of using ICT to motivate people to improve their literacy and numeracy skills.
As part of their Innovative Practice with e- learning programme, JISC have produced a good practice guide to embedding mobile and wireless technology into everyday practice www.jisc.ac.uk/learning_innovarion.html . This identifies some key benefits of using mobile and wireless technologies: portability, anytime, anyplace connectivity, flebile and timely access to learning resources, immediacy of communication, empowerment and engagement of learners, and activelearning experiences.

Embedded learning is also highlighted among a range of policy initiatives (more experienced practitioners will be sighing here – how is it possible NOT to contextualise, they might be muttering). The move towards functional skills, the closer to tie to employment and employability seem to suggest that learning materials and methodologies should all have a practical, useful for work aspect. At the same time, learning must be individualised in the new world order, with learners’ particular interests and needs targeted more precisely.

A recent publication “Personalizing Learning in the 21st Century” edited by Sara de Freitas and Chris Yapp, www.networkpress.co.uk highlights the powerful synergy between personalisation of the learning experience and the use of new digital and portable technologies.

Where then, might m-learning help Skills for Life practitioners to fulfil their ever-changing role?

First, some definitions. M-learning means mobile learning and is used to describe a range of teaching and learning practices which use new technologies: mobile phones, PDAs (personal digital assistants), iPods, GPS equipment, laptops. We should also bear in mind that the new generation of games consoles have, or will have web browser capability. However the important point to remember according to the educational community, is that it is the learner who is mobile and the device is of secondary importance.

From an original 3 year European project lead by the LSDA(see http://www.lsneducation.org.uk/research/centres/RCFTechEnhanceLearn/mobile/index.aspxsee) other research projects (mainly carried out by the NRDC) have burgeoned and commercial products have emerged which are quietly transforming learning in several parts of the UK and beyond. M-learning can no longer be sidelined as a slightly weird way of amusing learners for half an hour: it is moving into the mainstream of learning, meeting the needs of a range of learning styles. The discussion now might be more about where in the learning cycle m-learning fits most usefully.

m-learning materials
Downloadable quizzes, games and activities

m-learning materials currently take several forms. First, there is learning content which can be downloaded to a mobile phone. At its most basic, this might consist of quick multi-choice quizzes or games (e.g. snap, pairs) with literacy, numeracy or language content. Responses to the questions are made via the buttons on your phone and feedback is instantaneous. A version of this can be used with a printed text where answers are sent by sms and elicit an immediate response. You can see examples of these here http://www.m-learning.org/

It is possible (and desirable) to make the content for all of these activities contextualised into a specific area. This could be vocational e.g. for the construction or logistics industries or could meet the needs of a particular group e.g. young parents. Texts for sms response (http://www.m-learning.net/links/m-learning_SMS_details_2006.ppt) have an even wider scope. They can be made very specific and concentrate on a curriculum area and level such as decimals, fractions and percentages at L1 or broader with general literacy questions based on a particular setting such as a shopping mall or museum. It is now possible for practitioners to develop materials of this kind for their own groups of learners so that they are more "personalised" than the ringtone on your phone. The materials can be made with very little training using very basic technology (see http://portal.m/dashlearning.org/sms.qwizphp)

Once you have developed materials for a particular group of learners around a particular topic or curriculum area then you can decide where in the learning cycle your materials are a "best fit". You might decide to use them as a way of introducing a topic, or to practise a topic you have taught, or as reinforcement or homework. It's worth experimenting with materials and learners to see which works best.

More complex learning materials can be used on higher end phones with bigger screens. Animations and audio can be used to enhance the materials and to take learners through more complex conceptual scenarios. For example, one set of materials developed by Tribal CTAD demonstrates the use of a formula to work out stopping distances for a car going at different speeds with graphic and entertaining animation. (you can see this at Get Mobile details …)

Materials downloaded to phones or pdas can also be used in a directly vocational way. Some projects use pdas to illustrate particular practical tasks, for medical practitioners for example. It would be possible to illustrate a whole variety of vocational tasks in the fields of motor vehicle or beauty therapy for example, showing tricky procedures visually so that students who are practising tasks could have an instantly accessible illustration.

Private and personal

Materials you can buy or make yourself for mobile phones and xdas are useful, practical and accessible at any time and place by the learner. They exploit the affordances of the technologies – their portability and privacy aspects in particular. The learner has a greater degree of control and can fit practise into their daily lives. They can be used as a hook to attract people in to learning: the chances are this kind of approach will bear no resemblance to dark memories of classroom days. They are particularly useful for reinforcement or practise: the best example of this is probably the sets of quizzes designed to practise for the driving theory test.

mediaBoard and Blogging

A recent Nestafuturelab report 11-"Literature review in mobile technologies and learning" http://www.futurelab.org.uk/research/index.htm revealed six broad theory-based categories of

activity. Nesta identifies; Behaviourist, Situated, Constructivist, Collaborative, Informal and Lifelong and Learning and Teaching Support as categories of mobile learning.

One of the findings of the original m-learning project was that m-learning is particularly applicable in a constructivist approach to learning. During the trials of the materials, individuals would often share an activity or pass round a phone or pda among peers. Learning is often a social event and this has many benefits in the world of Skills for Life, in terms of motivating and inspiring people to take up and continue an offer to improve their skills and get involved in learning. The ICT angle of m-learning can be an incentive. There is kudos and personal gain in mastering new technologies and the confidence enhancing properties of mastering a PDA are spectacular. Many of the research projects have found that getting to grips with a PDA can provide extra confidence in tackling more mainstream IT applications, and can stimulate a new interest in using ICT to learn.

One of the ways in which learners can be involved in a group activity is by using a mediaBoard (http://www.mboard.org.uk/apps/demo/). The mediaBoard has almost limitless possibilities for learner led activities in a whole range of traditional and non-traditional contexts. In essence, it consists of a webspace (the "board" created by tutors or learners – or both together) where learners can send messages: text, picture and audio to established "zones" from their phone or pda. It is an example of how new technologies can take learning beyond the classroom in meaningful and relevant ways. Some examples of how mediaBoard can be used are:

- as the basis of a "treasure hunt". A tutor made from Southampton College set up a board from a collage of partial images collected from her local area. ESOL learners in teams were instructed to explore the area, find the original, take a picture on their pdas and send back to the board with a text message explaining what the image was and where they had found it.
- as a place to store evidence for a vocational qualification – catering students, for example, took pictures of processes and finished dishes with text explanation and comment
- as a kind of blog: learners can store pictures, sounds and information about themselves which can be as private or public as they choose
- as a tool for induction – participants can be sent out to areas around the workplace or learning centre and send back messages to a prepared board describing what happens where
- as a means to explore images of numeracy: in the Maths4Life ICT Pathfinder, a range of students from college and community took photos of what they saw as numeracy images and sent them to a Maths4Life board. The images were then used to discuss what people had found and to stimulate new numeracy projects based on the findings.
- as a means to explore local history: learners were given a quiz about the history of their area which was answered by taking pictures on phones, recording answers from museum staff and local people and sending them to a mediaBoard
- in Higher Education, students doing health related degrees are using boards to store a record of the work they do on placement – for themselves and for their tutors to keep track of what they are experiencing

Activities such as those described above show the possibilities of using new technologies to involve learners in discovery: the process of using the new technologies to record and send information is active and participatory. It is also possible to train participants to set up their own boards to be used by themselves and/or others: a possible first step to exploring the wider world of blogging.

Challenges

The development of new technologies identified by Becta in a recent publication www.becta.org.uk/publications combined with the emergence of "digital natives" and

“homozapiens” and their raised personal expectations contribute to a number of challenges/opportunities faced by the skills for life practitioner community.

Do we need to increase our understanding of the potential wireless and mobile technologies have for skills for life provision?

How do we develop the pedagogical and technological skills to support learners?
What are the issues around interoperability?
What are the implications for assessment and qualifications?
How can we ensure the quality of content?
Which agency should take the lead? How do ensure synergy and coherence and avoid disjointed incrementalism?
How do we avoid a “digital divide”?

Or shall we just let the learners take the lead?

A useful publication “Mobile Learning-a handbook for educators and trainers” Kukulska-Hulme,A and Traxler,J(2005), Open and flexible learning series, Routledge,London provides some useful insights into the potential of mobile and portable technologies.

One of the clear messages that has arisen from the research into using m-learning is that tutors can often feel unconfident about their skills in using new technologies – or, in some cases, any technology at all. There is a sense that tutors do not receive much initial training in using ICT and that this is not, as a rule, followed up with updates. There is a tendency to fall back on the tried and true and this can limit both the tutor and the learner. On the positive side, tutors who have taken part in research projects feel empowered by their new familiarity with the technologies and are enthusiastic and motivated to pass this on to learners (see Effective Practice study and M4L Pathfinder report).

Other issues include, of course, money. PDAs and tablet pcs are not cheap (although they are getting cheaper and now most phones have a built in camera and mms facility) and funders would need to be convinced of their relevance. However, particularly in terms of community groups and the harder to reach, they have the advantage of being more portable and convenient than laptops and lend themselves to the kind of innovative and motivating activities which might be more effective than more conventional applications of skills for life.

Skills for Life teaching pre Moser was often last on the list when it came to funding and innovation. The government’s strategy has changed all that and there has been a clear shift to a more central position. The current move to a more functional, embedded approach should not be an excuse to revert back to old skool methodologies and materials. A 21st Century workforce and citizenship needs to become familiar with a wide range of learning possibilities and new technologies should be part of this.

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Mlearn conferences since 2002. This paper was written in partnership with Jo Colley ,CTAD/Tribal.

He can be contacted on www.setuk.co.uk

Is Learning Really a Phone Call Away? Knowledge Transfer in Mobile Learning

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Abstract

Mobile learning can positively contribute to the development of learning communities by providing communication options that span contexts and locations, are available whenever, and are used virtually everywhere (Alexander, 2004; Sharples, Taylor & Vavoula, 2005). At UC Santa Barbara, we are currently conducting a campus-wide study that examines whether students' use of technology, both within and beyond the classroom, correlates with academic performance. While we primarily concentrate on the use of course websites accessed with non-mobile devices, we have begun to use a Performance-Based Feedback System (PBFS) to explore (1) how to extend the instructor-student feedback loop beyond the traditional classroom setting, (2) how knowledge transfer can be accomplished using mobile devices, and (3) what technical challenges must be overcome. In this paper, we examine ways that mobile networking technologies can foster the creation of learning communities and provide new methods for studying knowledge transfer.

Is Learning Really a Phone Call Away? Knowledge Transfer in Mobile Learning

For over a decade, instructors and educational researchers have identified the necessity of creating learning communities both within and beyond their classrooms (Flower, 1989; Gee & Green, 1998; Lave & Wenger, 1991). Ideally, learning communities promote deeper understanding of the classroom material through discussion and experiential activities. As with other areas of education, the challenge in developing these groups lies in fostering authentic activities that empower members to actively formulate and communicate their understanding of the materials. Emerging classroom technologies enhance the development of these learning communities by extending interaction beyond the classroom (Knight, Almeroth, & Bimber, 2006).

While the traditional model of knowledge transfer considers only instructor-student or text-student interactions, the social-constructivist approach offers a more flexible model conducive to mobile learning: peers learn from each other and through their interactions with resources across multiple modes and contexts (Mayer, 2001; Jonassen, 1996; Jonassen, Peck, & Wilson, 1999; Sharples, Taylor & Vavoula, 2005). To study knowledge transfer, then, we must examine the visible interactions between students, instructors, and resources as well as the meta-knowledge transfer that occurs between mobile devices and learning management systems.

In this paper, we use a Performance-Based Feedback System (PBFS) to examine how knowledge is shared, accessed, and revised among student learning groups in face-to-face learning environments as well as in distance-learning scenarios. We propose extending this model to mobile learning studies by first determining whether students are interacting using mobile devices and then developing a method for assessing this

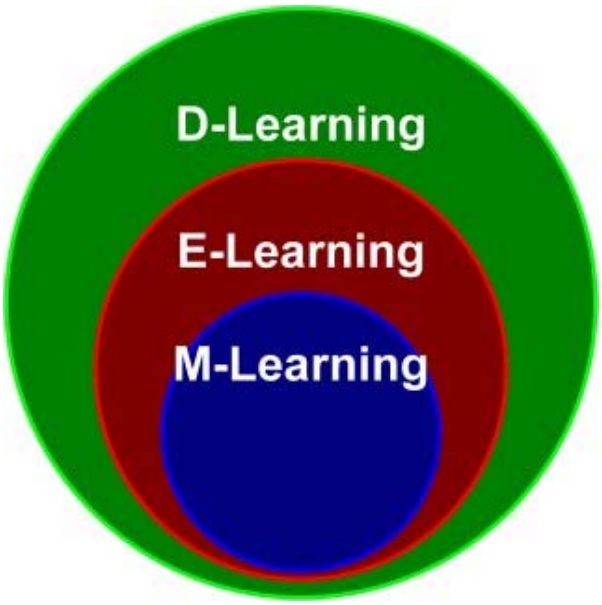

Figure 1. Popular perspective of learning techniques

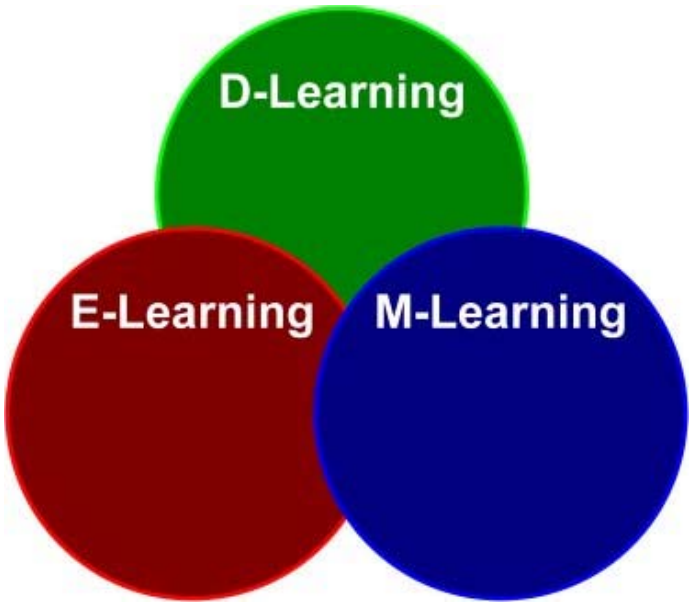

Figure 2. The MLearn Community Perspective

interaction. Mobile learning devices present a major technical challenge because they are not always connected; however, by leveraging existing mobile technologies such as ???, data such as what types of technologies students use in educational settings and when they use them can be collected. Once this data is collected and analyzed, we can build an understanding of how students use mobile devices and then tailor lessons to support and enhance this use. By integrating content development with data collection, we thus create a reflexive feedback model in which we identify, develop, test and refine pedagogically sound methods of using mobile technologies.

Understanding the ways students interact with technologies in learning contexts is a key first step to integrating mobile content and technologies in educational settings. To contribute to the ongoing assessment of mobile learning, we propose a methodology that uses a PBFS to study mobile learners and their mobile devices.

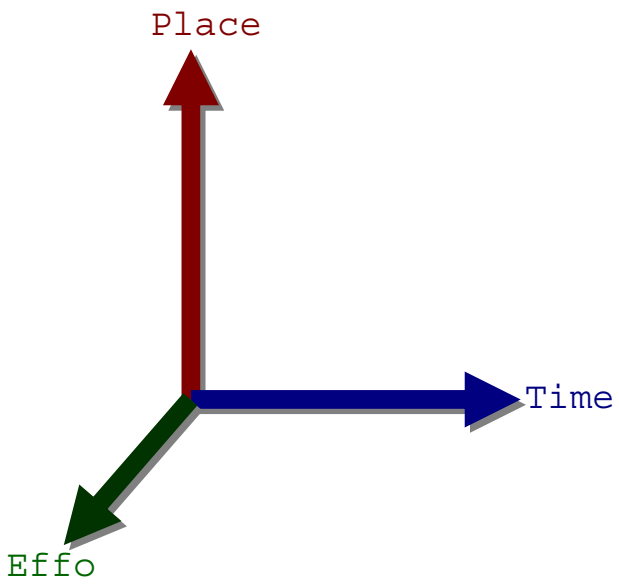

Figure 3. Our perspective of learning techniques

Perspectives on M-Learning

First, the popular misconception that the relationship between m-learning and both d-learning and e-learning is best expressed in terms of set theory. In this perspective d-learning is viewed as super set of all three paradigms with e-learning being a proper subset of d-learning. In other words, all instances of e-learning are also instances of d-learning. Similarly, m-learning is a proper subset of d-learning, and therefore all instances of m-learning are also instances of e-learning. Figure 1 illustrates this popular idea of their relationship. The MLearn community, however, takes a slightly different view of these relationships. Rather than viewing them as proper subset, the community correctly views them as three overlapping sets. In this view none of the sets are a proper subset of each other, but each set does slightly intersect with each other set. Figure 2 illustrates this perspective.

We, however, take a different approach to categorizing teaching techniques. Rather than arbitrarily assigning each technique to d-learning, e-learning or m-learning, we look at teaching practices in general in terms of 3 axes as shown in figure 2. The first access represents place. Locations at the origin represent learning that takes place with no spatial displacement from the classroom. Moving further up the axis represents larger and larger spatial displacement and therefore learning taking place further from the traditional classroom. The second axis represents temporal displacement. Here, the origin represents no temporal displacement from a fixed class meeting time. Locations further from the origin represent temporal shifts from the agreed upon class meeting time. By varying different learning experiences along both these axes, instructors can provide learning experiences at a greater number of times and places. All three of the learning paradigms, d-learning, e-learning and m-learning, are really achieved by varying the learning experience along these axes. The advantage of this organization is that it avoids the natural arguments that result from trying to classify specific teaching techniques. Is a book really an m-learning device? Is a PDA in the classroom really m-learning? With the popular view, and even the research view of learning, these questions are not easily answered and open to much debate. However, by using the axes to organize teaching techniques, the only concern is how much time and space are shifted for a particular learning experience. Finally, the third axis in Figure 2 represents effort. This axis measures how much effort is required to achieve a learning outcome by both the instructor and the student. In some cases the amount of effort required to implement a specific learning technique is not worth the benefits gained. Other techniques may require a small amount of effort in the beginning that results in less effort on the part of the

instructor or the student. The goal of the Course Management System (CMS) is an example of the instructor exerting an initial effort that results in less effort required by students and instructors to gain access to course material.

Currently, most courses are taught using techniques that fall in a variety of locations on these axes. Some teaching is done in the traditional classroom at a fixed time, which would appear at the origin of both the temporal and spatial axes. Other tasks may be done outside the classroom at any given time before a deadline. The goal then as educational and technology researchers is to find the position on these axes that maximizes the outcomes for students and instructors.

Related Work

In the following we describe three architectures created specifically for mobile learning environments. These pieces of research, while not exhaustive, represent the central themes of m-learning architectures. Each of the architectures contains modules for content management, presentation management and context awareness. Content management is the management of the learning objects themselves and provides for access to the various formats of the objects to the students. A pre-existing CMS from an e-learning environment generally provides this functionality. Presentation management refers to the modification of learning objects based on what device the object is accessed. Finally, context awareness refers to how, when and where an access of a particular learning object occurs. Context awareness, discussed in greater detail later in this paper, is the main focus of our research. Again, however, our work is not architecture, but rather a suggestion of an addition to all architectures especially in how they act upon their context awareness.

We first present Mobile Learning Management System (m-LMS) (Trafinova, & Ronchetti, 2004). The m-LMS provides the aforementioned modules as “Context Discovery”, “Mobile Content Management and Presentation Adaptation”, and “Packaging and Synchronization”. The m-LMS architecture is in reality an adaptation of an e-LMS to support m-learning. The e-LMS still handles the management of learning objects, however, in order to display these object properly the mobile device receives a modified version. In addition, the context discovery module helps to transmit the proper learning object to the mobile device based on the current context. The m-LMS architecture is similar to our work in that it seeks to guide students towards downloading the most appropriate material. The m-LMS architecture does not, however, inform the students of the importance of certain learning objects. Instead it merely downloads the most important learning objects to the mobile device.

Porta-bile(Colazzo, Molinari, Conchetti, & Trifonova, 2004) is the second architecture presented here and is similar in focus to the m-LMS project above. The focus is, again, the transformation of a learning management system primarily used for e-learning into an m-learning architecture. By building a web application on top of a pre-existing LMS using web services, their e-LMS is transformed into an m-LMS.

Finally, we present the architecture called Open Mobile Access Abstract Framework (OMAF) (Lonsdale, Baber, & Sharples, 2003). The work is part of a greater effort, called MOBIlearn, to observe the practicalities and effectiveness of mobile learning in general. This work presents a layered approach to m-learning architectures. The main difference between this work and the others mentioned above is that OMAF

represents an overall abstraction of how to design mobile learning environments, rather than actual architectures.

While all the above research has a common goal, which we share with them, of measuring the effectiveness of various mobile learning technologies, we believe there are two main deficiencies. First, with the exception of MOBIlearn, these research projects treat mobile learning as a proper subset of e-learning. We, believe that there exists m-learning opportunities that do not exist in e-learning. The second problem with these projects is their idea of context. For each, context refers to the temporal, spatial and hardware contexts. Our work would prefer to extend the idea of context to include the performance of the student using a particular device and the performance of others with respect to a particular learning object. By extending the context to include performance, we believe that the mobile learning experience can be enhanced further to allow the students to more likely access the learning objects that have a greater impact on their performance.

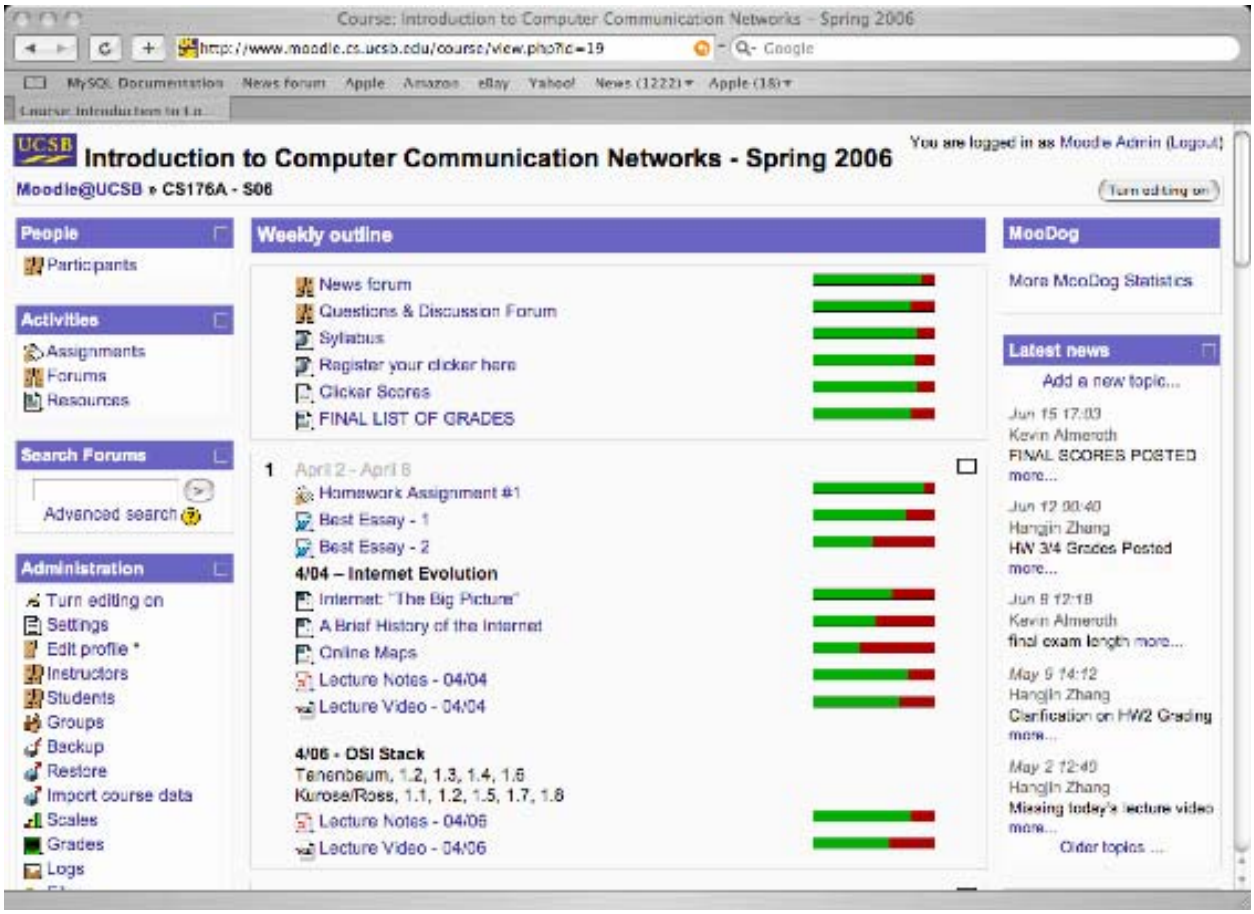

Figure 4. Screen capture of the Moodle extension MooDog. The red and green bars convey access information about learning objects.

Performance-Based Feedback Systems

The goal of our research with Performance-Based Feedback Systems (PBFS) is to introduce the feedback loop, much like that from a traditional classroom, into the d-learning, e-learning and m-learning environments. For example, if a student has not yet read a homework assignment that is due in the near future, the PBFS, as currently constructed, would e-mail the student a reminder that the assignment is due and that they need to read and start the assignment. While this scenario is currently possible with

current most CMSs, the time required to achieve such feedback is prohibitive. Analyzing the logging information of the Course Management System associated with a particular course make these scenarios possible. The hope is that by 'reminding' those students who have not kept up with the material and by keeping the instructor informed about these students, the overall performance of the students is improved. We have already begun to build and use such a system for Moodle. The MooDog extension for Moodle provides feedback to both student and instructors regarding how often learning objects have been accessed. Figure 4 above is a screen shot of MooDog.

The word "Performance" as used in our work has several implications. Primarily, the word refers to our goal of improving overall academic performance. Secondarily, "Performance" refers to the fact that performance of past and present students in a given course can be used to determine which learning objects are important to a course and what sort of interactions students have with these objects. Going back to the homework assignment example, it may be important to know how long before an assignment is due should a student begin, or at least read, an assignment. More importantly, does this time gap matter in the overall performance on that particular assignment.

To implement a PBFS requires three actions: Collection, Analysis and Presentation. The collection action has two distinct sources, the CMS system, which keeps track of learning object accesses and student information. The student information is necessary at this point to help us understand what factors truly impact their educational experience. This data allows us to differentiate between true enhancement of the learning experience and difference in Performance-Based on other background information such socio-economic status. The analysis actions use both types of information. Analysis

refers to the actual manipulation of data to determine an action for the PBFS. For example, if the PBFS observes that a particular student has not accessed a learning object associated with an upcoming assignment. The PBFS may then decide to inform that student that the assignment deadline is approaching and accessing the learning object may greatly affect the student's performance on that assignment. Analysis is also currently ongoing to determine the exact importance of viewing different types of learning objects. This analysis seeks to determine such metrics as how long before an assignment is due should a student read the assignment and presumably begin work on it to maximize performance. Similarly, this analysis seeks to determine which types of learning objects are the most effective. Are PowerPoint slides more important the student forums? Or is the opposite true? Finally, the presentation action notifies both the students and the instructors about accesses statistics of learning objects. The forms of these presentations can be e-mails in the case of students, and web pages with viewing statistics for both students and instructors. Figure 3 illustrates MooDog's presentation of access information for instructor use.

Performance-Based Feedback Systems in an M-Learning Environment

At the present time, our work primarily concentrates on e-learning environments. Recently, however, we have begun to look at how our work can complement m-learning environments. In looking at this new area, we realized integration into an m-learning environment would also enhance a PBFS. A PBFS in an m-learning environment creates more opportunities for collecting data. Better data collection is possible because mobile devices tend to be more application specific. For example, trying to surmise how much time students actually spend reading the content provided on a course website is difficult

to measure accurately, especially when viewed on a PC. Measuring time spent interacting learning objects on a PC is problematic in e-learning environments because PCs are capable of running several applications at once. On mobile devices such as PDAs or cell phones, which are less multipurpose, the possibility exists to more accurately collect data on learning object usage. This aspect of m-learning environments is, in our view, an important enhancement to the collection and analysis of performance data that will lead to even better measurements for the feedback system.

M-Learning with Performance-Based Feedback Systems

Most m-learning environments that we have read about involve some form of context awareness. The content, in the form of learning objects, is in someway modified, and/or selected, based on the temporal and spatial positions of the user and the hardware restrictions of the mobile device in use. The context of a request from a mobile device is the combination of these three characteristics, and maybe some others. One dimension of context missing, however, is what observed behaviors are associated with a particular learning object. For example, when, if at all, did the student access a learning object. This information is very important when selecting which objects to upload to a mobile device. Proper selection of learning objects for transmission to a mobile device is important because mobile devices are, by definition, limited in their resources. For example, in a situation similar to that given in Porta-bile, where a student is at the library around the deadline of an assignment, an m-learning environment may decide to transmit learning objects related to a talk at the library, but not inform the student of the impending deadline for an assignment. If the student has already viewed and/or submitted the assignment, then the original choices seem appropriate. If, however, the student has not

then the choice may not be optimal. This example is one of many where including student interactions with learning objects can result in better selection of materials to upload to the mobile device.

How then is the information necessary for proper feedback collected? If the mobile device is connected, traditional collection methods are appropriate. The CMS collects the requests and records them in a log. If, however, the mobile device lacks connectivity, then the data must be collected locally on the mobile device and forwarded to a central collection server in the future. This collection of data poses the main technological challenge for combining m-learning and a PBFS.

There exist several techniques for overcoming this challenge. If time is not important, then the collection server can download the information upon the next connection. If, however, time is important then other technologies may be necessary, such as those employed by delay tolerant networks, or by simply notifying the user that connectivity is required at the soonest possible time. Also important and of concern is when data collected offline consumes the limited resources of a mobile device. If connectivity does not occur in a timely manner, the data collected may accumulate to the point of using all available resources on the mobile device. By eliminating some information in the data collection, perhaps the oldest or least important, the mobile device can avoid consuming the limited resources available to it and upload the remaining information when connectivity becomes available.

Summary and Conclusion

In this paper we have discussed both Performance Feedback System (PBFS) and m-learning both as independent entities and when used in conjunction with each other. A

PBFS is a powerful tool to help students improve their performance in a class. Similarly, m-learning is an important tool for both improving the learning experience in traditional classrooms and making learning possible where it was not before. Their combination, however, enhances both. Allowing a PBFS more opportunities to collect usage data and with greater detail will help it make better choices about which objects to notify students and instructors about. M-learning, too, can benefit from incorporation of a PBFS. The additional dimension that a PBFS adds to context awareness will greatly improve the decision making process for any m-learning architecture. For the future, the combination of these two concepts will allow for better measurement of performance in class and a better experience in general.

References

Alexander, B. (2004). Going nomadic: Mobile learning in higher education. *Educause,* 29-35.

Colazzo, L., Molinari, A., Conchetti, M., Trifonova, A. Towards a Multi-Vendor Mobile Learning Management System. Proceedings of 2004 World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education (ELEARN), Phoenix

Da Bormida, G., Bo, G., Lefrere, P., Taylor, J. An Open Abstract Framework for Modeling Interoperability of Mobile Learning Services. Proceedings of MLearn 2004 Conference, Rome

Flower, L. (1989). Cognition, context, and theory building. *College Composition and Communication, 40,* 282-311.

Gee, J.P. & Green, J.L. (1998). Discourse analysis, learning, and social practice: A methodological study. *Review of Research in Education, 23,* 119-169.

Jonassen, D. H. (Ed.) (1996). *Handbook of research for educational communications and Technology*. New York: Macmillan

Jonassen, D.H. Peck, K.L., & Wilson, B.G. (1999). *Learning with technology: A constructivist perspective*. Upper Saddle River, NJ: Prentice Hall.

Knight, A., Almeroth, K. and Bimber, B. Observations and recommendations for using technology to extend interaction. Proceedings of 2006 World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED MEDIA), Orlando.

Lonsdale, P., Baber, C., and Sharples, M. A context awareness architecture for facilitating mobile learning. Proceedings of MLearn 2003 Conference, London

Lave, J. & Wenger, E. (1991). *Situated Learning: Legitimate Peripheral Participation*. Cambridge: Cambridge University Press.

Mayer, R. E. (2001). *Multimedia learning*. New York: Cambridge University Press.

Sharples, M., Taylor, J., Vavoula, G. (2005). Towards a theory of mobile learning. *Proceedings of MLearn 2005 conference,* Cape Town.

Trafinova, A., & Ronchetti, M. A General Architecture to Support Mobility in Learning. Proceedings of the 2004 IEEE International Conference on Advanced Learning Technologies (ICALT), Joensuu, Finland

Running head: MOBILE USABILITY IN EDUCATIONAL CONTEXTS

Mobile Usability in Educational Contexts: What Have We Learnt?

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Abstract

The majority of mobile learning activity continues to take place on devices that were not designed with educational applications in mind, and usability issues are often reported. The paper reflects on progress in approaches to usability and on recent developments, with particular reference to usability findings reported in a range of studies of mobile learning. The requirements of education are considered as well as the specific needs of students participating in distance education; discipline-specific perspectives and accessibility issues are also addressed. Usability findings from empirical studies of mobile learning published in the literature are drawn together in the paper, along with an account of issues that emerged in two mobile learning projects based at The Open University, UK, in 2001 and 2005. The main conclusions are: that usability issues are often reported in cases where PDAs have been used; that the future is in scenario-based design which should also take into account the evolution of uses over time and the unpredictability of how devices might be used; and that usability issues should be tracked over a longer period, from initial use through to a state of relative experience with the technology. The paper offers a checklist of factors impacting on the usability of mobile devices in education.

Mobile Usability in Educational Contexts: What Have We Learnt?

Introduction

The past few years have witnessed the development of a substantial body of literature reporting pilot projects in learning with mobile devices, and a surge of conferences pertaining to mobile learning research, including the annual Mlearn conference. The papers describe mobile systems and software that have either been purpose-built for education or that use off-the-shelf solutions originally intended for business use. In spite of careful designs and preparations on the part of the researchers and practitioners running the projects, issues of usability are known to arise in both situations, preventing learners from engaging fully with their educational tasks.

We have reached the stage in mobile learning research where the considerable body of evidence from various projects and trials can enable us to begin to review in a more global way what has been learnt to date about the usability of mobile devices in education. Admittedly, this is a vast topic and it is not possible to generalise from a range of user experiences that span different technologies, contexts of use, study modes and learning objectives. Nevertheless, there is much to be learnt from being aware of the kinds of usability issues that have arisen in the past. The aim of this paper is two-fold: first, to reflect on progress in approaches to usability and on recent developments in the field, and second, to review usability issues reported in a range of studies of mobile learning. In doing so, it is interesting to pay attention to the particular needs of students participating in distance education, many of whom would consider themselves to be the original ‘mobile learners’, used to carrying their course materials around with them and accessing them in flexible ways. For these students, learning with mobile devices represents another step in the right direction but it also presents some specific challenges.

Accounts of mobile usability issues that pertain to education can be found in many sources, most notably in specialist conference series, in themed journal issues and in published case studies (e.g. JISC, 2005). A systematic review of all the available sources would be a valuable exercise; for the purposes of this paper, a number of recurring issues are identified and highlighted as a step towards a systematic review. In the meantime, those who design future studies, those involved in the design and implementation of mobile learning, and the designers of new mobile devices and software can begin to benefit from this evolving collective experience.

As well as examining usability issues reported in specific studies, it is helpful to see them against the background of the state of play in mobile usability and in relation to requirements that might be specific to education. The next two sections address these two aspects in turn.

Mobile Usability

Mobile usability can be regarded as an emerging specialism within the more general field of usability, which has also been evolving. Human-computer interaction researchers recognize that to produce computer systems with good usability, it is important to understand the psychological, ergonomic, organizational and social factors that determine how people operate. Nielsen (1993) explained usability in terms of a system's overall acceptability, which included its social acceptability and all practical aspects such as reliability, cost, compatibility and usefulness. More recently, Preece, Rogers and Sharp (2002) have focused on "creating user experiences that enhance and extend the way people work, communicate, and interact" (p. v). The affective dimension is also being foregrounded: Dix *et al*. (2004) remark that "users no longer see themselves as cogs in a machine… it is not sufficient that people can use a system, they must *want* to use it" (p. 156); whilst Porter *et al*. (2005) emphasise an inclusive view of the individual by attempting to understand their emotional and 'pleasure' needs as well.

However, although researchers in human-computer interaction are forging ahead in developing their visions for helpful and engaging interactions, the reality for many computer users remains quite different. Influential authors like Cooper (2004) and Nielsen (2005) continue to point out the usability shortcomings of current computer software and technology. Shneiderman (2002) has stated that too often computer software is “just too hard to figure out” (p. 24). Yet Shneiderman also believes that new computing methods can produce “more usable, more reliable computer software and user interfaces that yield much improved user experiences” (*ibid*, p. 26).

How do mobile technologies fit into this picture? Are mobile devices bringing us closer to the ideals of usable computing - or distancing us away from them? The user interfaces on mobile devices are often relatively simple, but each manufacturer has a different interface. Devices are also continually being replaced with new models, even before users have got to know them well:

> In many markets, mobile phones have a product life cycle of 12 months or less. Some subscribers are able to put their new phones to immediate and full use. For others, the learning curve is so steep that they move on to a replacement without having learned to exploit the functionality available in the first one. (Gilbert *et a*l., 2005, p.1)

Furthermore, hardware limitations that have long been overcome in desktop systems are back on the usability agenda when mobile devices have to be charged regularly, run out of memory and may be unreliable. New factors have also come into play: the very nature of mobile

interaction is that it is frequently interrupted or fragmented, may be highly context-dependent, and takes place in physical environments that may be far from ideal.

In his book devoted to handheld usability, Weiss (2002) remarked on the "general lack of usability on most handheld devices" (p. xiii), whilst Nielsen's verdict on mobile usability in 2003 was that "the latest mobile devices… still lack key usability features required for mainstream use" (Nielsen 2003:1). In relation to mobile phones and PDAs in an art gallery setting, Sharples *et al*. (forthcoming) have remarked that "…the relative lack of usability in the technological domain inhibits developments in the semiotic". Recent developments have been characterised by an increasing awareness of contexts of use and how these might evolve. For example Turel (2006) argues that the emergence of mobile value-added services has introduced a broad range of new use contexts, requiring a new conceptual model of mobile usability. Similarly in relation to mobile data services, Gilbert *et a*l. (2005) propose a dynamic perspective of users' out-of-the-box (initial use) experience, embracing differences over time in both the 'external' and 'internal' contexts among users, such as user location, demographics or lifestyle characteristics.

Current thinking suggests that in mobile learning, user-centred design and attention to contexts of use will lead to better mobile learning usability. Pehkonen and Turunen (2003) have argued that in the case of mobile learning, user-centred design means not only planning learning goals and actions but also specifying different contexts of use and the requirements of different 'actors', which might include teachers, students and even parents. Malliou and Miliarakis (2005) and Evans and Taylor (2005) have also advocated user-centred and scenario-based design. Lessons from the MOBIlearn project (O'Malley *et al.*, 2003) include a guideline on usability which suggests observing "the usability requirements of all those involved in the use of the system in any way (learners, teachers, content creators) to assure system acceptability" (p.32).

The guideline elaborates that in designing mobile applications and producing mobile content, it is important to consider the context of use and that the learner should be able to receive personalised information "that is valuable to her in the given context" (*ibid*, p.32).

With many factors impacting on the usability of mobile devices in education, it is not yet clear whether these user-centred and context-sensitive approaches are the necessary and sufficient ways to ensure a high degree of usability in mobile learning. Those who are involved in designing mobile devices have been noticing that "new solutions are utilized in ways that never even occurred to their designers" (Keinonen, 2003: 2) - in other words, you cannot fully predict what users will choose to do - and whilst this is not an entirely new phenomenon, the highly personal and portable nature of mobile devices makes it more likely to happen. Besides, uses may become more elaborate over time: Gilbert *et al*. (2005) have drawn attention to the period after initial use of a mobile service, "during which the scope of use expands to fulfil emergent needs" (p.207).

Another approach to improving usability is to make the user interface or content adaptable to, or by, the user. Making information personally valuable in a given context, as suggested in the MOBIlearn guideline (*op cit*), is one way of adapting to the user. Jäppinen *et al*. (2005) have written about the pros and cons of *adaptivity* in the context of mobile learning: a system that can model the user and automatically regulate and organise its functioning is very appealing, but at the same time this property can make the system less controllable and predictable for the user. Malliou & Miliarakis (2005) put their faith in the *adaptability* of the mobile system in the MoTFAL project: "it should adapt to the learners' evolving skills and knowledge" (p.122) – as part of a set of requirements that are specified to assure its usability.

Returning to the idea that people must *want* to use a system (Dix *et al*., quoted above), we can hypothesize that people may acquire a mobile device for a specific purpose but its subsequent use may depend on, and evolve according to, their wants or needs. As noted earlier, they may never discover all the features of their device before moving on to another one, because what they want, or what someone else thinks they want, is a new device. What has not been well researched to date is how people get to know the features and possibilities of their mobile device and its applications over time. How that happens may be determined not only by the individual's effort but by their social networks – and by the extent to which mobile services and content are 'pushed' in their direction by various providers. In educational contexts, where mobile devices may be loaned out to students for a limited period of use, it may also be determined by (non-) ownership of the device. The impact of the education context on mobile usability is explored in more detail in the next section.

Requirements in education

Nielsen (2001) has remarked that although general usability standards apply equally to e-learning, there are additional considerations, for example the need to keep content fresh in learners' minds so that they do not forget things whilst trying to accommodate new concepts. User-centred system design and evaluation have traditionally been driven by the concept of a 'task'. To a certain extent, it is possible to list the kinds of tasks that learners engage in. For example Rekkedal (2002) has suggested that mobile learners in distance education need to be able to perform tasks such as studying the course materials, making notes, writing assignments, accessing a forum, sending and receiving e-mail, and communicating with a tutor. However, the process of learning is not always easily broken down into tasks, and something like "studying course materials" is no more than a label that conceals great complexity in how the materials

might be studied. Ryan and Finn (2005) have commented on the difficulty of task analysis in relation to mobile learning ‘in the field’, in the course of their attempts to define the generic requirements of users who typically operate out in the field (e.g. geologists, archaeologists, journalists, technicians, police). It is also very challenging to design and evaluate tools that support learners’ development and interactions with others over time.

Conventional approaches to usability tend to be limited to metrics relating to time taken to complete a task, effort, throughput, flexibility and the user’s attitude. Syvänen & Nokelainen (2005) have attempted to go beyond this by combining technical usability criteria (such as accessibility, consistency, reliability) with pedagogical usability components such as learner control, learner activity, motivation and feedback. Kukulska-Hulme and Shield (2004; Shield & Kukulska-Hulme, 2006) have also argued that usability needs to be understood differently when it is being evaluated in the context of teaching and learning, and that the concept of pedagogical usability can be helpful as a means of focusing on the close relationship between usability and pedagogical design. Exploring this concept raises the question of whether there are aspects of pedagogical usability that are discipline-specific; this is examined by Kukulska-Hulme and Shield in relation to the discipline of language learning. In websites that support language learning, usability might depend on whether the site uses the first or target language and on its ability to support multimodal and intercultural communication. The ways in which language experts conceptualise user interfaces may also be specific to the culture and sub-cultures of their discipline. These aspects can be hard to quantify and measure but it does not mean that they are less important.

Discipline-specific perspectives can be identified in a number of mobile learning projects. For example, in the accounting project reported by Roberts *et al*. (2003), screen size on the PDA

(personal digital assistant) was found to be an important issue because of the particular needs of the discipline, namely data entry and spreadsheet requirements. Polishook's (2005) research into the possibilities for student music composition on PDAs showed that for some individuals, the small, poorly lit low-resolution screens, tiny dialogue boxes, and the need to connect extra wires, stood in the way of productive use for music composition.

Educational activity can sometimes be better understood by system designers when it is seen as an example of a 'rich context' involving different people, the spaces they meet in and the physical artefacts they use (Dix *et al*., 2004, p.639-49). Collaboration and co-construction of knowledge are nowadays seen as being the defining characteristics of learning, in contrast to cognitive models that previously concentrated more on the individual learner without much consideration of their social and physical environment. In relation to mobile learning, Luckin *et al*. (2005) have defined a learning context as an 'ecology of resources' and have shown how technology can link different resource elements within and across learning contexts.

Empirical studies of mobile learning

What we have learnt from empirical studies of mobile learning? Many published studies and conference papers mention aspects of usability, either because it was something that was specifically evaluated, or more often, because usability issues arose during a project or trial and seemed worth mentioning. Sometimes testing the usability of a system is a milestone that will determine whether the system is going to be developed further; for example, Hitz and Plattner (2004) state that if the usability tests on their prototype PaperLink system yield satisfactory results, they will proceed to a generic mobile implementation.

Usability is typically considered from the point of view of issues or problems encountered by users, but good usability essentially means that learning can proceed without

obstacles and might even be enhanced by the availability of certain features. In Kukulska-Hulme (2005), a dozen case study accounts of mobile learning were analyzed from a usability perspective and positive aspects were also identified. For example, Trinder, Magill & Roy's case study (2005) highlighted the advantage of the immediate readiness of PDAs – the fact that they can be switched on and used straight away with no 'boot up' time – making them ideal to grab a few moments' useful working time at times and in locations where even a laptop would not be useful. Trinder, Magill and Roy also claimed that among their learners, the ability to beam items between PDAs encouraged collaboration and communication. In a similar vein, Corlett and Sharples (2005) report the finding that a keyboard was fundamental to making full use of the pen Tablet device. Bradley, Haynes and Boyle (2005a) give a number of recommendations to make multimedia content on PDAs usable in a local history tour and for learning Java programming, for example increasing the contrast of images and using audio commentary rather than text. Ryan and Finn's (2005) approach – mentioned earlier in relation to field-based learning – also falls into the category of studies that focus on planning-in good usability features rather than eliminating bad ones once they have occurred.

Examples of usability issues that are being reported in the research literature can be summarised under the following headings:

Physical attributes of mobile devices

Sharples *et al.* (2005) report that students expressed discontent about the size and weight of their PDAs, their inadequate memory and short battery life. The memory was considered too small to hold the course resources, additional PDF and media files, added software, games and music files. Bradley, Haynes and Boyle (2005b) report that limited storage space was an issue on the PDAs used in their project; but they also mention that the size of the PDA was viewed

positively by students, who appreciated being able to have a quick look at the PDA while walking, just before an exam, rather than having to carry a book or A4 papers; in those circumstances the small screen of the PDA did not seem to present a problem.

Screen size was identified as the biggest drawback to using PDAs in an outreach project described by Sugden (2005), noting especially that for sight impaired learners "the environment is impossible" (p.116). In a project reported by Rekkedal (2002), the students "expressed very different views" concerning reading from a small screen. It seems that a small screen may be an issue, but not always. Current opinion is that learners' age may be a factor (van 't Hooft, 2006) and that in the future, virtual screens and keyboards may help overcome the small screen issue (Ally, 2006).

Content and software applications

"Learning how to work with a PDA takes more time than people first think, despite the apparent similarity to Windows applications", according to researchers in the Manolo project (2005). In a slightly different context, Hackemer and Peterson (2005) note that whilst students were comfortable with their handheld's built-in functions, additional applications proved problematic, as most of the available software lacked formal usability assessment and documentation; this resulted in very few students being willing to explore applications in order to understand how they could be used. Smørdal and Gregory's study (2005) showed up problems in cutting and pasting material from one application to another, which limited the usefulness of the PDA as a communication device.

Selecting from a list of options can be a way to make it easier to interact with a mobile device, and indeed Cacace *et al*. (2004) report that drop-down lists and checklists proved useful in a mobile medical training context. On the other hand, Waycott's study in a museum setting

(Waycott *et al*., 2005) identified that choosing from a list of pre-written messages on the screen of the PDA did not necessarily facilitate peer-to-peer communication. The applications and circumstances of use were very different.

Network speed and reliability

In Smørdal and Gregory's study (2005) the slow transmission of web pages on GSM-connected PDAs resulted in a negative experience. A JISC case study (2005) in the use of wireless Tablet PCs at a London college identified occasional weak signals and slow access to documents as negative aspects of wireless connectivity within the college. Roberts *et al*. (2003) list wireless network reliability as one of the five key lessons that emerged from a mobile learning pilot project in accounting involving some 300 college students: "For maximum success, the technology has to work reliably. While small screen size and the lack of a keyboard were noted as PDA limitations, they did not generate the level of dissatisfaction among PDA students that the poor wireless WAN network functionality did" (p.33). On the other hand, with regard to speed, Cinque *et al.* (2005) report that their medical and nursing students tended to prefer a smaller device, with colour display, to a faster one, noting that "usability seems more important than performance" (p.115).

Physical environment

Corlett and Sharples (2005) report several usability issues that arose in their pen Tablet project, including difficulties in using the device out of doors due to excessive screen brightness. Bradley, Haynes and Boyle (2005b) noted that amongst their participants there were some concerns about personal security (the risk of being mugged), and about possible radiation from devices using radio frequencies. Manolo project (2005) case studies in environmental sciences

report the need to use rain covers on PDAs outdoors in rainy or humid conditions, and the need to consider the risk of loss and theft of equipment on field trips.

Issues that appear to have a bearing on usability include device ownership and duration of use. In the study reported by Sharples *et al.* (2005) the lack of device ownership meant that since students were required to return their handhelds at the end of the year, they did not want to invest in additional memory modules that would have overcome the memory limitations of their PDA. Waycott *et al*. (2005) also comment that in case studies involving PDAs, "where participants were prepared to invest effort in learning how to best use them for their own purpose, they could benefit from this investment as they were using the PDAs over a long period of time" (p.124).

The impact of usability issues on academic and technical staff are also mentioned in the literature. Luckin *et al.* (2005) have described the substantial overhead of staff time in terms of technical support, account administration and finding workarounds for features that did not work as required. The Manolo project (2005) has also emphasized the need for various types of support, including technical support, in its published summary of lessons learned from the project.

Finally, in consideration of learners with disabilities, Dodd, Pearson and Green (2005) have warned against new teaching methods becoming dependent on inaccessible mobile technology:

> Existing devices, exemplified by PDAs, inherently small and used in badly lit, noisy, and moving environments, amplify the demands placed on vision, hearing and mobility skills. (…) Current solutions focus on adapting existing commercial products to incorporate impairment-specific devices using Braille keyboards, and screen reading/magnification

> technology. Whilst this solves accessibility problems for a narrow band of users, it does not provide the coordinated approach necessary to support disabled users with more than one physical impairment. (Dodd, Pearson & Green, 2005, p.49).

This last point has particular implications for distance education, as relatively large proportions of disabled students participate in this form of education. The next section reviews the experiences of distance students in relation to the usability of mobile technologies.

Usability of mobile devices in distance education

As noted by Ally (2005a), the use of mobile technology in distance education could provide more flexibility for learners, a view that has also been put forward by Rekkedal (2002). Ally nevertheless makes the point that mobile learning requires organizational change and careful planning: existing course materials must be converted and new ones developed for delivery on mobile technology; it is necessary to establish a telecommunication infrastructure, train staff and faculty, and so forth.

Most experiences of mobile learning to date relate either to conventional teaching contexts, i.e. face to face teaching in universities, colleges and schools, or to informal learning in public spaces such as museums and gardens, but there is some experience specifically in distance education. For example work on mobile learning has been ongoing at the Norwegian Knowledge Institute - NKI Distance Education - for some years now (Fagerberg, Rekkedal & Russell, 2002; NKI Distance Education, 2004). Researchers at Birmingham University's former Centre for Educational Technology and Distance Learning (recently rebranded as CLIC) continue to work on distance and continuing education issues (CLIC, 2006), as do researchers at the University of Athabasca (McGreal, 2005; McGreal, *et al*., 2005; Ally, 2005b).

In this section, the focus is on two projects at The Open University in the UK, both of them concerning the use of mobile devices by students on the Institute of Educational Technology's Masters programme in Online and Distance Education (MAODE). This is a distance learning programme primarily delivered online, making use of web resources and conferencing. Students on the programme are typically studying part-time and are involved in other professional activities. They are mostly in their 40s and come from a variety of cultural backgrounds. The first project summarised here investigated students' use of PDAs that were given to them, whilst the second project investigated their use of their own mobile devices.

1. PDAs for reading course materials

During 2001, a study was conducted to evaluate the use of PDA devices by students on the Masters course *H802: Applications of IT in Open and Distance Education* (Waycott & Kukulska-Hulme, 2003; Waycott *et al*., 2005). The idea was to give students the option of reading some of their course materials on a PDA. Students could choose to read on a PDA or only the print version, or both. As part of this project, cognitive, ergonomic, and affective aspects of PDA use were investigated in some detail (Kukulska-Hulme, 2002).

All 65 students enrolled in the course were supplied with PDAs; most were new to using this type of device. The study aimed to assess the benefits and constraints introduced by PDAs, and to examine how this new tool impacts upon students' reading strategies; annotating and note-taking were included in the investigation. WordSmith, a document editor and viewer, was used to present course materials on the PDA. The document viewer mode enabled users to read and search the text in several ways. Participants received the manufacturer manuals, and they were also provided with further instructions tailored to their needs. They did not have access to any specific technical support during their use of mobile devices. The model of mobile learning in

this project was that of individual learners accessing materials on their individual devices, and to a certain extent using their own initiative to explore the features and capabilities of the device, although they could share their problems and questions in the online conference.

The conference for this project was opened up to students in the run-up to the distribution of PDAs; this became a focal point for early adopters, i.e. those students who were already users of other handheld computers, or who were immediately interested in the technology. Once the PDAs were distributed, the conference was accessed by a wider circle of students. Numerous hardware, software, synchronisation and compatibility problems were discussed, and students made comparisons between the PDA and other devices they were familiar with, including their desktop computers. A number of issues emerged during the evaluation period, for example, in relation to reading, skim-reading on a PDA could be slower than skim-reading in print; what students noticed when reading print could also be different. When the font was enlarged on the PDA, scanning could be harder. Taking electronic notes and annotating the text could also be difficult on the PDA. Observations that accompanied this study showed that some users had difficulty gripping the very thin stylus and inadvertently pressed buttons at the bottom of the device. It was also noted in this project that the sensitivity of the screen seemed to vary from one PDA to another, and in some cases it was necessary to re-calibrate the screen so that it responded to the stylus. Even with limited use of the PDAs, it was clear that scratches could start to develop on the screen, making it less sensitive, and perhaps less usable, over time.

The project concluded that three main issues needed to be considered in future projects of this kind: *usability of the hardware* (considering that the PDA used in the project was a relatively inexpensive model; the screen contrast was very low and required great concentration); *usability*

of the software (the application used for reading texts was not designed for reading), and *usability of the text* (the text had not been designed with a PDA in mind).

2. Survey of how MAODE alumni use mobile devices

This project ran in 2005 and its participants were registered alumni of the same Masters in Online and Distance Education (MAODE). The alumni had completed at least one-third of the programme, and in some cases all of it. Fifty-seven alumni completed an online questionnaire and 9 were subsequently interviewed. The purpose was to gather both numerical and qualitative data on the breadth of their use of mobile devices: which did they use, for what activities, and how? Participants were asked whether they had used a mobile phone, smartphone, PDA, and MP3-player (for example, an iPod). For each device, they were asked whether they had used it for teaching, work, learning, social interaction, and entertainment (including quizzes and games). And for each activity they selected, they were asked to give an example. Informal uses (with friends, family or interest groups) could be included when responding about 'teaching' and 'learning'. There was also a catch-all question about any other uses, and in addition participants were asked how often they carried out specific activities with a mobile device, such as reading an e-book, browsing a website, or making a video clip (for more complete accounts of this project**,** see Kukulska-Hulme and Pettit, 2006; Pettit and Kukulska-Hulme, 2006).

A review of the data from the survey shows that the use of PDAs generated the greatest number of spontaneous comments relating to usability. These were not always negative comments. Forty-six percent of the respondents had used a PDA. In relation to uses connected to their work, respondents commented that they used the PDA in preference to a laptop while travelling by train because the battery lasted longer than the one in their laptop, and because a PDA was more comfortable to use in 'airline' seats that do not have a proper table. A separate

keyboard was used by three of the respondents. In relation to their use of the PDA for learning, comments included trying to download documents to read but finding the screen far too small; preferring print rather then the PDA, to read and scribble on on the train; and trying to use blogs on the PDA but finding the formatting not good enough. Positive aspects of learning-related usability were using time productively while waiting, and being “always up to date”. In relation to social interaction, one respondent regretted not having wi-fi and another had tried conferencing on the PDA but found it “too clunky, too hard to write on”.

Although the data only offers a small selection of comments mentioning aspects related to usability, there is some indication that the PDAs do present some usability issues, particularly in the context of learning. On the other hand, when looked at from the point of view of productive use, respondents reported using their PDAs in a rich variety of ways; included in this were activities such as brainstorming, mindmapping, reading ebooks, downloading academic articles, accessing email, keeping a list of library books to take out, loading copies of software manuals, web browsing, and use of multiple media (photos, video, music).

Conclusions

The paper presented a review of current usability issues in the use of mobile devices in the context of education, almost exclusively in relation to adult learners. In doing so, a broad interpretation of usability has been adopted, encompassing not only technical but also pedagogical considerations, which are often closely intertwined. As we have seen, the field of mobile usability is in a state of evolution, as it reflects and indeed takes forward some of the developments in the field of usability as a whole. Similarly, there is ongoing discussion of what are the important issues with regard to mobile technology uses in education. In a general review, it is not possible to make definitive statements about usability based on what is often reported in

an ad-hoc way in the literature, however some interesting points emerge that can guide our thinking in the future. Figure 1 brings together all the factors impacting on usability that have been mentioned in this paper: a checklist that may serve as a reference point in future mobile device usability evaluations – and indeed mobile device evaluations more generally. Figure 2 is an alternative visual representation of the items in the checklist.

- Physical attributes of the device: device features and user interface
- Accessories used with the device
- Device ownership
- Personalisation features
- Familiarity with the device
- Duration of use and evolution of use over time
- Motivations for use
- General software that participants are expected to use
- Content, applications and services provided or accessed
- Reliability of device or network
- Speed of access or connectivity
- Pervasiveness of access
- Locations and conditions in those locations
- Conditions of travel
- Continuity and interruptions
- Linkage across contexts of use
- Set tasks and user-generated activities
- Study activities and discipline perspective
- Support for collaboration
- Enhancement or extension of current activity
- User demographics
- Lifestyle characteristics
- Requirements of other people or ‘actors’ involved
- Social networks or groups
- Social acceptability of use
- Emotional and pleasure needs
- Costs of use
- Technical support
- Accessibility and adaptability
- Compatibility or conflict with other tools used
- Unpredictable and emergent uses and needs

Figure 1. Checklist of factors impacting on the usability of mobile devices in education

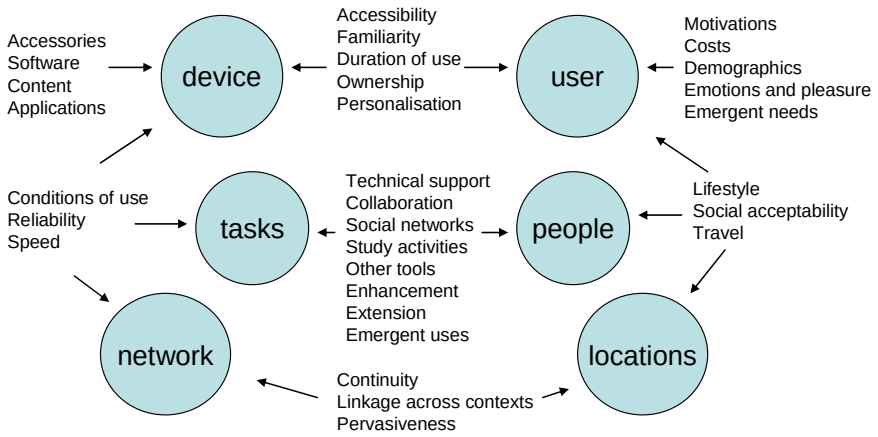

Figure 2. Factors impacting on the usability of mobile devices in education

The majority of mobile learning activity continues to take place on devices that were not designed with educational applications in mind. It is noticeable that usability issues are often reported where PDAs have been used, which suggests that PDAs might be the object of more usability problems than is the case for mobile phones, for instance. If that is indeed the case, then one possible explanation is that devices such as mobile phones and mp3 players are more likely to be personally owned by, and hence more thoroughly familiar to, their users; Antoniou and Lepouras (2005) assert that owners' familiarity with their mobile phone avoids many potential usability problems for mobile learning in a museum setting. There is also some evidence to the contrary – for example it was noted earlier in this paper that users may not know their mobile phone all that well as they are always moving to a newer model; but this may be more applicable

to some sectors of the population than others. Another explanation for the extent of reported usability issues in connection with PDAs is that PDAs may feature in more mobile learning studies, as phones and other devices have not so far been researched in learning contexts to quite the same extent (but this is changing). Furthermore, the pace of change in technological developments means that the PDAs used in earlier studies do not necessarily present the same challenges as more recent equipment. Arguably, some usability issues may have been overcome: McGreal *et al*. (2005) take the view that the technological capacity of PDAs …"has increased dramatically in the past three years. Screens are bigger and better; systems have more memory; they have more multimedia capabilities; and there are more refined methods for inputting data" (p.50). It is likely that users' experience with the devices is much improved as a result, although we do not yet have sufficient evidence.

It looks like the future is in scenario-based design, but this should also take into account the evolution of uses over time and the unpredictability of how devices might be used. Discipline-specific perspectives ought to be brought into play, and accessibility must continue to be considered alongside usability. Findings will always be context-dependent to a considerable extent, but it should be possible to accumulate knowledge about user experience in particular physical environments and situations of use. Some sets of mobile learning guidelines have already been published and they include some mention of usability. Generic requirements for certain types of user are also being elaborated. One final point to make is that rather than testing for usability at just one or two specific points in the life of a project, it would also be beneficial to find ways of tracking usability over a longer period of time, from initial use through to a state of relative experience.

References

Ally, M. (2005a). Use of Mobile Devices in Distance Education. *Mlearn 2005 Book of Abstracts*. Cape Town, South Africa.

Ally, A. (2005b). Multimedia information design for mobile devices. *Encyclopedia of Multimedia Technology and Networking.* Ed. M. Pagani. Idea Group.

Ally, M. (2006). *Mobile Devices Usability*. Posting on the CIDER Mobile Learning SIG forum, June 11, 2006. Retrieved November 10, 2006 from:

http://cider.athabascau.ca/CIDERSIGs/mobilelearning/mlearndiscussion/talkback/1150066275

Antoniou, A., & Lepouras, G. (2005). Using bluetooth technology for personalised visitor information. *Proceedings of the IADIS international Conference on Mobile Learning*. June 2005, Qawra, Malta.

Bradley, C., Haynes, R., & Boyle, T. (2005a). Design for multimedia m-learning: lessons from two case studies. *ALT-C 2005 Research Proceedings*. University of Manchester.

Bradley, C., Haynes, R., & Boyle, T. (2005b). Adult Multimedia Learning with PDAs – The User Experience. *Mlearn 2005 Conference Proceedings*. Cape Town, October 2005, 23-27.

Cacace, F., Cinque, M., Crudele, M., Iannello, G., & Venditti, M. (2004). The impact of innovation in medical and nursing training: a Hospital Information System for students accessible through mobile devices. *Mlearn 2004 Conference Proceedings*. Rome, Italy, 5-6 July 2004. [Electronic version]. Retrieved November 10, 2006 from: http://www.crudele.it/papers/00269.pdf

Cinque, M., Cacace, F., Crudele, M., Iannello, G., & Bernaschi, M. (2005). Mobile learning in a hospital environment. *Proceedings of the IADIS international Conference on Mobile Learnin*g, 28-30 June 2005, Qawra, Malta.

CLIC (2006). Centre for Learning, Innovation and Collaboration, formerly the Centre for Educational Technology and Distance Learning. University of Birmingham, UK. Retrieved November 10, 2006 from: http://www.clic.bham.ac.uk/

Cooper, A. (2004). *The inmates are running the asylum: why high-tech products drive us crazy and how to restore the sanity*. Indianapolis: Sams Publishing.

Corlett, D., & Sharples, M. (2005). Tablet technology for informal collaboration in higher education, in: J. Attewell & C. Savill-Smith (eds) (2005) *Mobile Learning Anytime Everywhere: Papers from Mlearn 2004*, LSDA, 59-61.

Dix, A., Finlay, J., Abowd, G.D., & Beale, R. (2004). *Human-Computer-Interaction*. 3rd edition. Harlow: Prentice-Hall.

Dodd, R., Pearson, E., & Green, S. (2005). A systematic approach to mobile accessibility. *ALT-C Conference abstracts*. 6-8 September 2005. Manchester University.

Evans, D., & Taylor, J. (2005). The role of user scenarios as the central piece of the development jigsaw puzzle. In: J. Attewell & C. Savill-Smith (eds) (2005) *Mobile Learning Anytime Everywhere: Papers from Mlearn 2004*. LSDA, 63-66.

Fagerberg, T., Rekkedal, T., & Russell, J. (2002). Designing and trying out a learning environment for mobile learners and teachers. NKI Distance Education – Electronic College. Retrieved November 10, 2006 from:

http://www.nettskolen.com/forskning/55/NKI2001m-learning2.html

Gilbert, A.L., Sangwan, S., & Han Mei lan, H. (2005). Beyond usability: the OoBE dynamics of mobile data services markets. *Personal and Ubiquitous Computing*, 9, 4, 198-208.

Hackemer, K., & Peterson, D. (2005). University of South Dakota Palm initiative. In: Kukulska-Hulme, A., & Traxler, J. (2005) *Mobile Learning: A Handbook for Educators and Trainers*, London: Routledge.

Hitz, M., & Plattner, S. (2004). PaperLinks – linking printouts to mobile devices. *Mobile learning anytime everywhere: Papers from MLEARN 2004*. eds. J.Attewell and C. Savill-Smith, London: LSDA,105-108.

Jäppinen, A., Ahonen, M., Vainio, T., & Tanhua-Piiroinen, E. (2005). Adaptive mobile learning systems – the essential issues from the design perspective. *Mobile learning anytime everywhere: Papers from MLEARN 2004*. eds. J.Attewell and C. Savill-Smith, London: LSDA, 109-111.

JISC (2005). Case studies of innovative practice: wireless and mobile learning. Project led by Agnes Kukulska-Hulme at The Institute of Educational Technology, The Open University, UK. Retrieved November 10, 2006 from: http://www.jisc.ac.uk/whatwedo/programmes/elearning_innovation/eli_oucasestudies.aspx

Keinonen, T. (2003). Introduction: mobile distinctions. In: C. Lindholm, T. Keinonen & H. Kiljander (eds) *Mobile Usability: how Nokia changed the face of the mobile phone*. New York: McGraw-Hill.

Kukulska-Hulme, A. (2002). Cognitive, Ergonomic and Affective Aspects of PDA Use for Learning. *Proceedings of European Workshop on Mobile and Contextual Learning*. University of Birmingham, 20-21 June 2002.

Kukulska-Hulme, A. (2005). Mobile Usability and User Experience. In: Kukulska-Hulme, A., & Traxler, J. (2005) *Mobile Learning: A Handbook for Educators and Trainers*, London: Routledge.

Kukulska-Hulme, A., & Pettit, J. (2006). *Practitioners as innovators: emergent practice in personal mobile teaching, learning, work and leisure*. Mlearn 2006 conference paper, Banff, Canada, October 2006.

Kukulska-Hulme, A., & Shield, L. (2004). *Usability and pedagogical design: Are language learning websites special?* Paper at ED-MEDIA'04 - World Conference on Educational Multimedia, Hypermedia and Telecommunications, Lugano, Switzerland, 22-26 June 2004. [Electonic version]. Retrieved November 10, 2006 from: http://www.aace.org/DL/index.cfm?fuseaction=ViewPaper&id=16072

Luckin, R., Brewster, D., Pearce, D., du Boulay, B., & Siddons-Corby, R. (2005). Whether it's m-learning or e-learning, it must be ME learning. In: Kukulska-Hulme, A., & Traxler, J. (2005) *Mobile Learning: A Handbook for Educators and Trainers*, London: Routledge.

Luckin, R., du Boulay, B., Smith, H., Underwood, J., Fitzpatrick, G., Holmberg, J., Kerawalla, L., Tunley, H., Brewster, D., & Pearce, D. (2005). Using mobile technology to create flexible learning contexts. *Journal of Interactive Media in Education* (Portable Learning: Experiences with Mobile Devices. Special Issue, eds. Ann Jones, Agnes Kukulska-Hulme and Daisy Mwanza), 2005/22. Retrieved November 10, 2006 from: http://jime.open.ac.uk/2005/22

Malliou, E., & Miliarakis, A. (2005). The MOTFAL project: mobile technologies for *ad hoc* learning, in: J. Attewell & C. Savill-Smith (eds) (2005) *Mobile Learning Anytime Everywhere: Papers from Mlearn 2004*. LSDA, 119-122.

Manolo (2005). *Guidelines for integrating e-, w-, and m-learning.* Project deliverables – lessons learned. Retrieved November 10, 2006 from: http://www.spinlab.vu.nl/manolo/

McGreal, R. (2005). *Mobile devices and the future of free education*. Paper at ICDE World Conference 2005. Delhi, India: International Council for Distance Education.

McGreal, R., Cheung, B., Tin, T., & Schafer, S. (2005). The Athabasca University Digital Reading Room: Library Resources for Mobile Students. *Proceedings of the IADIS international Conference on Mobile Learning*, 28-30 June 2005, Qawra, Malta.

Nielsen, J. (1993). *Usability Engineering*. Boston MA: Academic Press.

Nielsen, J. (2001). Just how important is usability in e-learning*? Elearning Post*. Retrieved November 10, 2006 from: http://www.elearningpost.com/articles/archives/jakob_nielsen_on_e_learning/

Nielsen, J. (2003). *Mobile Devices: One Generation from Useful*. Retrieved November 10, 2006 from: http://www.useit.com/alertbox/20030818.html

Nielsen, J. (2005*). Top Ten Web Design Mistakes of 2005*. Jakob Nielsen's Alertbox October 3, 2005. Retrieved November 10, 2006 from:

http://www.useit.com/alertbox/designmistakes.html

NKI Distance Education (2004). *Mobile Learning – The Next Generation of Learning*. White Paper, October 2004. Ericsson. Retrieved November 10, 2006 from:

http://whitepapers.silicon.com/0,39024759,60133005p-39000592q,00.htm

O'Malley, C., Vavoula, G., Glew, J.P., Taylor, J., Sharples, M., & Lefrere, P. (2003). *MOBIlearn WP4 – Guidelines for learning/teaching/tutoring in a mobile environment*. Retrieved November 10, 2006 from: http://www.mobilearn.org/download/results/guidelines.pdf

Pehkonen, M., & Turunen, H. (2003). Preliminary guidelines for the design of the mobile learning activities and materials. *EUROPRIX Scholars Conference: Conference Papers and*

Presentations. Tampere: European Academy of Digital Media, MindTrek Association. Retrieved November 10, 2006 from:

http://www.mindtrek.org/liitetiedostot/materiaalit_editori/75.doc

Pettit, J., & Kukulska-Hulme, A. (2006). Going with the grain – mobile devices in practice. Forthcoming paper, ASCILITE conference, Sydney, December 2006.

Polishook, M. (2005). Handheld composing: reconceptualizing artistic practice with PDAs. In: Kukulska-Hulme, A., & Traxler, J. (2005) *Mobile Learning: A Handbook for Educators and Trainers*, London: Routledge, 133-138.

Porter, C.S., Chhibber, S., Porter, J.M., & Healey, L. (2005). *RealPeople: making users' pleasure needs accessible to designers*. Paper at Accessible Design in the Digital World Conference 2005. Retrieved November 10, 2006 from:

http://www.bcs.org/server.php?show=ConWebDoc.3762

Preece, J., Rogers, Y., & Sharp, H. (2002). *Interaction Design: Beyond Human-Computer Interaction*. New York: John Wiley & Sons.

Rekkedal, T. (2002). *M-learning for PDAs: enhancing the flexibility of distance education*. Powerpoint presentation at Ericsson Education, November 2002. Powerpoint presentation. Retrieved November 10, 2006 from:

http://learning.ericsson.net/mlearning2/project_one/presentation/torstein1911.ppt

Roberts, J., Beke, N., Janzen, K., Mercer, D., & Soetaert, E. (2003). *Harvesting fragments of time: Mobile learning pilot project*. Final Report, May 1, 2003. Toronot: McGraw-Hill Mobile Learning Pilot Project Consortium.

Ryan, P., & Finn, E. (2005). Field-based mlearning: who wants what? *Proceedings of the IADIS international Conference on Mobile Learning*, 28-30 June 2005, Qawra, Malta.

Sharples, M., Corlett, D., Bull, S., Chan, T., & Rudman, P. (2005). The Student Learning Organiser. In: Kukulska-Hulme, A., & Traxler, J. (2005) *Mobile Learning: A Handbook for Educators and Trainers*, London: Routledge.

Sharples, M., Taylor, J., & Vavoula, G. (forthcoming). A theory of learning for the mobile age. To be published in R. Andrews (ed.) The *Handbook of Elearning Research*. London.

Shield, L., & Kukulska-Hulme, A. (2006). Are language learning websites special? Towards a research agenda for discipline-specific usability. *Journal of Educational Multimedia and Hypermedia*, 15 (3).

Shneiderman, B. (2002). *Leodardo's laptop: human needs and the new computing technologies*. Cambridge, M.A.: MIT Press.

Smørdal, O., & Gregory, J. (2005). KNOWMOBILE: mobile opportunities for medical students. In: Kukulska-Hulme, A., & Traxler, J. (2005) *Mobile Learning: A Handbook for Educators and Trainers*, London: Routledge.

Sugden, D. (2005). Exploring the physical frontiers of e-learning. The use of personal digital assistants (PDAs) in outreach centres. *ALT-C 2005 Research Proceedings*. University of Manchester.

Syvänen, A., & Nokelainen, P. (2005). Evaluation of the technical and pedagogical mobile usability. Mobile learning anytime everywhere: A book of papers from Mlearn 2004, eds. J.Attewell and C. Savill-Smith, London: LSDA, 191-195.

Trinder, J., Magill, J., & Roy, S. (2005). Expect the unexpected: practicalities and problems of a PDA project. In: Kukulska-Hulme, A., & Traxler, J. (2005) *Mobile Learning: A Handbook for Educators and Trainers*, London: Routledge, 92-98.

Turel, O. (2006). Contextual effects on the usability dimensions of mobile value-added services: a conceptual framework. *International Journal of Mobile Communications*, 4, 3, 309-332.

van 't Hooft, M. (2006). *Usability issues*. Posting on the CIDER Mobile Learning SIG forum, May 26, 2006. Retrieved November 10, 2006 from: http://cider.athabascau.ca/CIDERSIGs/mobilelearning/mlearndiscussion/talkback/1148656719

Waycott, J., & Kukulska-Hulme, A. (2003). Students' Experiences with PDAs for Reading Course Materials. *Personal and Ubiquitous Computing*, 7, 1, 30-43.

Waycott, J., Jones, A., & Scanlon, E. (2005). PDAs as lifelong learning tools : an activity theory based analysis. *Learning, Media and Technology*, 30, 2, 107-130.

Weiss, S. (2002). *Handheld Usability*. Chichester: John Wiley & Sons.

Figure Captions

Figure 1. Checklist of factors impacting on the usability of mobile devices in education

Figure 2. Factors impacting on the usability of mobile devices in education

Running head: EMERGENT INNOVATIVE PRACTICE

Practitioners as Innovators: Emergent Practice in Personal Mobile Teaching, Learning, Work and Leisure

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Abstract

Mobile devices have become commonplace tools serving a wide array of purposes that may include teaching and learning alongside work and leisure, in both formal and informal settings. The project reported on in this paper was an investigation of how personal mobile devices are used by 57 students and alumni from the global Masters Programme in Online and Distance Education offered by the Institute of Educational Technology at the Open University, UK. The focus was on the types of activity undertaken, innovative or unexpected uses of mobile devices, and any issues mentioned by participants. Data was collected in 2005 by means of an online questionnaire and follow-up interviews with a subset of respondents. The questionnaire contained both quantitative and qualitative questions relating to the use of four types of device, user communities and groups, the frequency of specific uses, and users' views on the attractions and disadvantages of mobile learning. The research is intended to help inform those who are interested in the potential of mobile learning, who are designing learning with a specific type of mobile device in mind, or who own a mobile device but may not be making the most of it for their own teaching and learning.

Practitioners as innovators: emergent practice in personal mobile teaching, learning, work and leisure

Introduction

Mobile learning has reached the stage where the ‘early adopters’ and ‘early majority’ (Rogers, 2003) are making the use of mobile and wireless technologies visible across a broad range of contexts and applications. At the same time, the technological and social diversification of the field means that it has become much more open to innovation on the part of educators, i.e. practitioners in teaching and training, whereas in the not too distant past it tended to be largely in the preserve of researchers and specialists. Evidence is provided by the availability of case studies that show how educators are taking advantage of mobile learning to bring about significant enhancements and transformations in their teaching practice (e.g. JISC, 2005; Manolo, 2006). Mobile devices have also become commonplace tools serving a wide array of purposes that may include teaching and learning alongside work and leisure, in both formal and informal settings. Consequently learners, too, are often able to contribute more actively to developing innovative educational uses of the technology as they interweave them with other aspects of their lives.

We were interested to find out more about the ways in which those who are engaged in teaching and learning use mobile technologies, and in particular in relation to spontaneous learning and teaching practices and the intersection with daily life and work. We were also intrigued by anecdotal evidence that owning and carrying around one or more mobile devices may encourage users towards experimentation which in turn could lead to innovative uses. Edwards (2005) suggests that users of various mobile devices should try out activities they haven’t tried before, e.g. subscribing to news, accessing location-based content, viewing video

and listening to audio, since “the best place to start is by experiencing first-hand what it’s like to get the information you need in the format and location you want” (p.4). Edwards contrasts this informal and user-driven approach with more conventional, formal learning initiatives that don’t take into consideration current trends like mobile working and the constraints on people’s time.

The project we report on in this paper was an investigation of how personal mobile devices are used by students and alumni from our Masters Programme in Online and Distance Education, offered by the Institute of Educational Technology at The Open University, UK. Students and alumni of this programme are typically experienced practitioners working in the education sector and many of them are keen users of new technology. In 2001–2, a number of students from the Programme had had the opportunity to explore the use of mobile devices as part of a research project aimed at understanding their experiences with PDAs that had been provided for reading course materials (Waycott & Kukulska-Hulme, 2003). Whilst we believe, along with Ally (2005), that issues of mobile ‘content delivery’ are very much alive and need a great deal of attention, our more recent focus has been the complementary activity of investigating emergent practice. By ‘emergent practice’ we mean the ways in which students and alumni use mobile devices as learners and as teachers, spontaneously and autonomously rather than because they have been asked to. We are also interested in the interplay with other areas of their lives such as work and leisure. Edwards (2005) has noted that it is important to think beyond repurposing content for distribution on mobile devices and to focus more on understanding how people communicate, collaborate and learn.

Our research aims to contribute to the understanding of innovative practice at the level of the individual empowered by a personal mobile device and social networks that may amplify or modify its use. In our roles as disseminators of innovative e-learning practice both to colleagues

and students in our university and externally (e.g. Kukulska-Hulme, 2005), we also aim to use our research to help inform those who are interested in the potential of mobile learning, who are designing learning with a specific type of mobile device in mind, or who own a mobile device but may not be making the most of it for their own teaching and learning. We would like to see more widespread discussion of how users can best discover and develop the potential of their mobile devices, individually and collectively, and we hope that our research can help raise the profile of that discussion.

Mobile learning practices in the research literature

In evolving definitions of mobile learning, we are seeing technology-focused approaches being gradually superseded by interpretations that seek to locate mobile learning within broader educational frameworks, taking account of social and philosophical dimensions (Traxler, 2005; Laouris, 2005). The context for this is the rapidly changing landscape of teaching and learning. The growing importance of lifelong and informal learning has a special connection with the affordances of mobile technologies; but whilst this has long been emphasized by Sharples (1999), it has taken some time to gain momentum.

Scanlon *et al*. (2005) have been exploring what possibilities exist for science learners in informal settings, and in projects across many subject domains it is not unusual now to find a stated aim of developing systems or materials for informal learning. For example, Fallahkhair *et al*. (2005) have developed a system to support informal mobile language learning, while Bradley *et al.* (2005) report on the development of materials for a mobile local history tour. This type of ‘designed’ informal learning may be contrasted with situations where mobile devices are used spontaneously for learning, employing only the device features and software that are already available for general use or that have been sought out by users in response to their own needs or

interests, perhaps for everyday learning. In connection with the latter, Vavoula *et al.* (2004) have studied mobile learning as part of everyday learning, in order to uncover "how people learn on the move or outside their normal learning environment, with the technologies that are currently available, such as mobile phones and PDAs" (p.1). Vavoula (2005) compared episodes of mobile learning (when the learner is not at a fixed location or when she/he takes advantage of mobile technologies) to non-mobile learning, and found "indications that mobile learning is more interactive, involves more 'bustle', more contact, communication and collaboration with people" (p. 17).

Informal mobile learning is also a theme in the work of Oksman (2005), who has reported on research at the University of Tampere exploring mobile communication and Internet use among young people, families and older people since the late 1990s. Berth (2005) has been studying the use of mobile phones in the intersection between formal and informal learning contexts. There is also growing interest in the new social practices associated with the use of particular mobile technologies (e.g. pervasive image capture and sharing, Spasojevic *et al*., 2005). However, overall the research literature in the area of everyday informal mobile learning and its integration with daily life is still limited. If we take seriously one of the main conclusions of the Mobilearn project - that "Learning is interwoven with other activities as part of everyday life…Mobile learning is integrated with non-learning tasks such as shopping or entertainment" (Sharples, 2005) – then the case for understanding the technology-mediated relationship between learning and other activities is emphasized.

In relation to teaching practices and mobile devices, Leach *et al.* (2005) have been investigating the impact of new portable technologies on teachers' practices in the context of their professional development. The work shows very clearly that personal uses such as diary

and address book functions go hand-in-hand with successful use of the same mobile device for planning teaching and collecting resources for teaching. Wishart's (2006) research in the use of PDAs in initial teacher training gives similar findings concerning the integration of the PDA as both personal organiser and a tool for making notes on information and events as they are encountered. The first year evaluation of Duke University's iPods initiative reported that academic uses consisted of course content dissemination, data capture in the classroom and in the field (capturing discussions, notes, digital assets), study support, and file storage and transfer (Belanger, 2005). These studies demonstrate that a multifunctional portable device enables users both to attend to administrative tasks and to develop their practice in a variety of locations. The Duke University initiative continues to encourage the development of practice through "creative uses of technology in education and campus life" (Duke University, 2006).

Participants and methodology

Participants in our research (hereafter referred to as *alumni*) were drawn from among those who had successfully completed at least one of the courses in our Masters Programme in Online and Distance Education (MAODE). This is a global, distance learning programme which has been running since 1997. Recent alumni have good or excellent levels of computer literacy (the programme is delivered online and several of the modules explicitly focus on aspects of elearning technologies), but even those who completed courses much earlier could reasonably be expected to have at least some knowledge of ICT. We therefore expected that the alumni would include at least some who had interesting and innovative experience of using mobile devices. Since the MAODE programme is aimed largely at those practising or intending to practise in education and training, it seemed likely that the alumni would throw light on some of the ways in which mobile devices are being used in education and training, and would also reveal how

practitioners are using such devices in other areas of their life – in their own learning, social interaction and entertainment.

Given the geographically dispersed locations of our participants, data for the project was collected in 2005 by means of an online questionnaire and follow-up interviews by telephone or email with a subset of respondents. The questionnaire contained both quantitative and qualitative questions relating to the use of different types of device (namely, mobile phones, smartphones, PDAs, mp3 players) in five types of activity:

- teaching
- learning
- work
- social interaction
- entertainment (including quizzes and games)

It covered the use of mobile devices as part of user communities and groups, the frequency of specific uses (such as browsing websites, reading e-news, sharing media files, etc.) and users' views on the attractions and disadvantages of mobile learning. It was sent out to 150 alumni and elicited 57 responses.

The main section of the questionnaire focused on the use of mobile devices. Respondents were asked to give one or more examples in detail to show how they use(d) the devices for the five types of activity. We were mainly interested in teaching and learning; however, the three remaining categories were included with a view to examining whether the other areas of use might have implications for teaching and learning.

The questionnaire stated that the terms 'teaching' and 'learning' should be interpreted to include informal uses, for example teaching or learning with friends, family or interest groups -

as well as formal situations inside or outside the classroom. For some respondents, ‘work’ equates with ‘teaching’ because of their job. When analysing the questionnaire data we were particularly interested in the types of activity undertaken; innovative or unexpected uses of mobile devices; and issues mentioned by users. The questionnaire results are reported with special regard to those aspects. As a means of data collection, the questionnaire had typical advantages and drawbacks: in particular, the open-ended questions elicited a good array of examples that could not have been anticipated in advance, but they also allowed for a few ambiguous responses that proved hard to interpret.

Nine interviewees were subsequently invited to amplify the responses they had made in the questionnaire a few months previously. Our approach was broadly phenomenological; in relation to the data arising from the interviews, we were interested in gathering individual stories but aimed not to take these as unsituated accounts. The interviews illustrate ways in which respondents are using mobile devices in diverse situations, and they provide insights into user choices in relation to contexts of use, ergonomic issues and personal preferences. The nine interviewees were chosen principally because their questionnaire responses suggested they were engaging in interesting or novel applications, but we also took care to include at least some participants from outside the UK. The interviewees were therefore not chosen as being representative of the cohort; nevertheless, they gave the opportunity to move outside the categories of the questionnaire and to capture details of individual accounts and contexts. The interviewees talked about their choice of device, the content of their activities, and the contexts in which they used their devices, both formal and informal. All the interviews were carried out by an experienced researcher who was independent of the project; they were transcribed by an administrative assistant and anonymised before being passed on to the authors of this paper. The

interview findings are only covered briefly in this paper; a fuller account is available in Pettit & Kukulska-Hulme, 2006.

Questionnaire findings

In this section we report the main findings of the questionnaire. About three-quarters of the respondents were aged 35–54 and a little over half (55%) were female. Over half lived principally in the UK, with most of the remainder living in continental Western Europe, and 5 living in Hong Kong, Japan, Peru and the USA. Nearly all described their profession as associated in some way with education or training.

Almost all respondents reported that they had used a mobile phone, and about half stated they had used a PDA or mp3 player. Smartphones were used by 18% of those who answered this question; a smartphone was defined in the questionnaire as: ‘a mobile phone/PDA in one device’.

The findings are reported here firstly in relation to the four types of device and the five areas addressed in the questionnaire, namely teaching, learning, work, social interaction, and entertainment. We believe the most valuable aspect of the findings is the range and variety of activities mentioned by respondents for each type of device, because of our overarching aim to continue using our research to help disseminate innovative practice. For each type of device, we concentrate on listing the activities that were undertaken by respondents rather than the frequency with which they were mentioned. Subsequently we also report on what respondents told us about being part of groups and communities, whether they had undertaken specific activities listed in the questionnaire, their views of what’s special about mobile learning and what they perceive to be the single biggest disadvantage.

Mobile phones

Of those who had used a mobile phone, 96% reported using it for social interaction and 78% for work. Outside these uses, the figures were much lower: 30% for teaching; 19% for entertainment, quizzes and games; and 17% for their own learning. Common mobile phone uses across the categories of activity were contact, scheduling and reminders, and as an alternative means of support.

The main use of mobile phones in *teaching* was for activities relating to contacting students, scheduling and reminders, as an alternative medium for support and as a way to motivate learners to participate. Communication by mobile phone occasionally included the use of photographs and short news. In addition, respondents mentioned teaching others about mobile devices, for example how mobiles can be used for more than just voice communication, but in those cases it seems that the phone was used in demonstration mode.

In *learning*, apart from contact, scheduling and learning support, respondents reported browsing the web, downloading e-books, learning Greek and receiving the table of contents of journals. One respondent used the phone as a modem for PDA network access.

In the *work* context, contact, scheduling and reminders were again the dominant uses. Some respondents gave more specific reasons, e.g. getting taxis, out-of-hours technical support, coordinating location with a colleague. Uses that might be considered slightly more unusual were: text messages in response to correspondence, storing information in Japanese, and telephone interviews for research. The issue of the acceptability of texting was touched upon by one respondent who claimed never to use texting for work.

In *social interaction*, the vast majority of respondents used their mobile phone simply for calls and for texting friends and family. Although this majority use was very predictable, there

were some interesting comments and examples in this category. One unusual use of the mobile phone was as support for mild visual impairment, namely contacting a spouse when the respondent had lost sight of her in a shop. One respondent emphasized the use of very short messages (congratulations, football scores, “where are you now”). Exchanging photos, pictures, jokes, ringtones and multimedia messages were mentioned; also checking the time of the next bus. Circumstances of use were sometimes alluded to: using the phone only to leave an important message (and where there is no option of a public phone), using it mainly when on the move, using free minutes only, primarily as an emergency phone, or to be “always available”; in four cases, running late was a specific reason for use. One respondent referred to health fears (possible danger of exposure).

In *entertainment*, games, quizzes and competitions were mentioned but these were minority pursuits. There were some negative comments regarding the use of mobile phones for entertainment, including the following:

- “Have tried it but not my cup of tea”
- “Did try receiving Virgin bite sized but they were so irritating. Virgin mobile culture seems whacky and crazy and I am neither.”
- “Tried – couldn’t figure it out”
- “Rarely – too slow”
- “Very rarely, when all other sorts of entertainment have failed.”

Photos were mentioned, in one case connected to mobile blogging (“this entertains the community of mobloggers on the site”). Respondents also referred to news as a form of entertainment.

Smartphones

As mentioned earlier, not many respondents had a smartphone but those who did have a smartphone reported some activities that had not been mentioned in connection with mobile phones.

In *teaching* and *work*, use of a smartphone meant access to online documents, a virtual learning environment (Blackboard), a student forum and websites. Communication by email was mentioned by a handful of respondents. Learning activities included use of email, accessing resources on the web, downloading chapters to read, quick access to Alta Vista Babelfish (a translation tool), and groupwork ("participating in groupwork remotely, using handsfree"). It should be noted that each of these uses was typically mentioned by one person, so they were not common activities.

Work activities included note-taking, task list, presenting Powerpoint slides, web browsing and share trading, as well as synchronisation with a Tablet PC. In *social interaction*, messaging, emails and voice calls were prevalent; specifically, the use of SMS during videoconferencing was reported by one participant. In the *entertainment* category, mention was made of games on the bus home, taking and sending photos, email and information such as news.

PDAs

The data relating to the use of PDAs was the most substantial in terms of the range of examples in the work context and the number of spontaneous comments about the experience of using PDAs.

Uses of PDAs in *teaching* included preparing materials; using digital sound files to record progress and achievement; getting students to take photographs (with text labels). Access

to information, e.g. articles, tables of contents and e-books, was mentioned by several respondents, as was administrative support: lists of talks, tutorials, tasks and students.

In the context of *learning*, carrying or reading texts (e-books, manuals, and various documents related to courses) appeared to be the most common activity, although note-taking and annotation were mentioned. A small amount of scheduling and web browsing took place, including web access to a discussion forum. This section generated a number of spontaneous comments regarding usability. On the positive side, it was possible to “use time productively while waiting” and to be “always up to date”; but on the negative side, the screen could be “far too small” for reading, and formatting of blogs was considered not to be good enough “at the time”.

In relation to *work*, the PDA had many different uses, including various ways of holding or capturing small amounts of information: contacts, action lists, notes, memos, as an “aide-memoire”, for “miscellaneous scrappy files”, for agenda-setting, and for mindmapping and brainstorming. Larger files were also mentioned, e.g. e-books, full text papers, a drugs database and medical textbooks. Recording or tracking was another area of use, e.g. recording meetings; keeping a record of continuous professional development; and tracking expenses or the amount of time spent on projects. Typical Office applications (Word, Excel, Powerpoint) were also used, email was sometimes accessed, and there was scheduling of appointments and meetings. A world clock was used by one respondent to check time differences. The use of PDAs for work generated a couple of spontaneous positive comments regarding usability, namely that battery life was better than on a laptop and that the PDA was more comfortable to use in ‘airline’ seats that do not have a proper table – making it suitable for use while travelling.

The categories of s*ocial interaction* and *entertainment* elicited relatively sparse responses but included music/mp3s, photos, video, e-books, and MSN messenger. One respondent had tried conferencing but had found it “too clunky”; another reported using the PDA to synchronize with various news sites.

Mp3 players

Mp3 players, devices that are primarily destined for entertainment (mp3 files were described by one participant as being “perfectly suited to disposable pop music”), were actually used in a wide variety of ways for all categories of activity, particularly in learning.

In *teaching*, they were used to distribute music and sound drills to students, to play files from CDs, to download interviews for classes. Mp3 files were recorded from BBC radio 4 and the World Service. Mp3 players provided background music in workshops, they were used as a voice recorder to record students’ spoken reflections on their learning (subsequently included on a spreadsheet or in Powerpoint), and for gap fill and listening exercises. Several issues were brought up by respondents, namely that the microphone was not good enough to record music; cheaper devices have controls that are “extremely awkward and unfriendly”; and that audio can be good when working with adults with learning difficulties or in practical classes.

In the context of *learning*, respondents downloaded ebooks; copied audio courses onto an iPod (and listened when travelling by bike, train and plane; at home too); listened to podcasts, pre-recorded lectures and recorded conferences; created mp3 files from Real Media lectures; and recorded lectures and conferences. Mp3 players were used in connection with a foreign language – to understand Spanish better (with listening materials downloaded from the web) and for recordings of Japanese language drills and dialogues. They were used as a storage device between work and home or when travelling. Another reported use was recording and playback

for conversation analysis. For one respondent, the iPod was their “favourite personal learning device”.

For *work*, the devices were used as a backup for Contacts; to transfer files between home and work; to carry a kiosk version of Firefox browser; to carry presentations; to share audio, video, and photo materials; with speakers, to play sample music to clients; and on business trips (“when can’t sleep”).

In *social interaction*, they were used (with speakers) on holiday, to play music to friends; for iPod parties and for photos. In *entertainment* they were used for pleasure during journeys, in the office, for walks and jogging; to play solitaire; to hold a database of an entire DVD library and important contacts; to download BBC documentaries; and for music ‘audio books’ and ‘talking books’. One respondent saw music as a potential distraction when concentration at work was needed.

Being part of groups and communities

In this part of the questionnaire, we aimed to find out whether participants had used a mobile device to be part of a group or community. Only nine respondents answered this question. Two types of group were mentioned: traditional and online. Traditional communities or groups were teachers, a group of students, colleagues in the same department, a work group, former clients, family, community groups focusing on historic preservation, and a residents’ association. Two online communities were a gaming community and moblogging, the latter involving sharing and discussing photos (“the moblogging community are more rewarding and reinforcing than family/friends”).

General benefits that respondents derived from group or community activity were keeping abreast of developments, keeping in touch, a sense of satisfaction from fulfilment of

civic responsibility, support from peers, and being able to offer support back to others. The online gaming community enabled meeting people from around the world ("my partner doesn't like computer games so the community is important to me"); the moblogging community was an occasional distraction from the respondent's job.

Specific uses for mobile devices

In this section of the questionnaire, participants were asked about suggested specific activities they may have undertaken using their mobile device, and to indicate the frequency of use by choosing one of 6 options (ranging from 'at least once a day' to 'never'). Twenty-three specific activities were proposed in the questionnaire, such as browsing websites, reading an e-book, taking a photograph, making a video clip, recording their voice, using a location-based service, etc. More unusual and more overtly interactive activities were also included, for instance "linking your device to someone else's, to play a game", making a video-phonecall, sending a sound file, sending an image. In this section, the activities were not related to the use of any particular type of device.

The most frequent activities, performed 'at least once a day', were:

- text messaging (38%)
- browsing websites – both 'ordinary' and set up for mobiles (20%)
- listening to an audio file (13%)
- reading e-news (9%)
- using a mobile device to make notes (7%)
- taking a photograph (6%)
- viewing a photograph or other image (6%)

When uses occurring ‘at least once a day’ and ‘a few days a week’ are combined, the most frequent activities were:

- text messaging (57%)
- browsing websites – both ‘ordinary’ and set up for mobiles (35%)
- using a mobile device to make notes (29%)
- moving files between a mobile device and a PC (28%)
- listening to an audio file (23%)
- reading e-news (23%)
- viewing a photograph or other image (21%)

Figure 1 shows a chart representing the above activities.

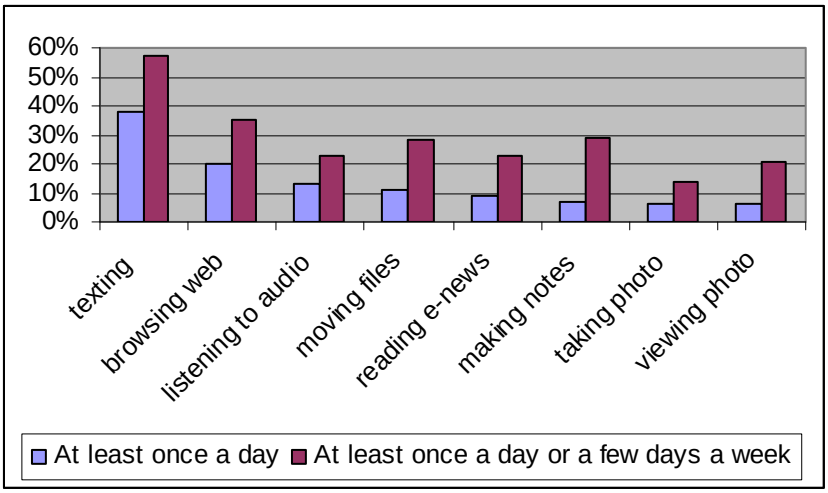

Figure 1. Most frequent activities

All twenty-three activities had at least one person indicating that they had undertaken that activity on a mobile device.

What’s special, what’s a problem?

When asked about what they considered to be *new and innovative* about their experience of learning with mobile devices, respondents mentioned that the devices were always available;

flexible; convenient; portable; inexpensive; easy to check again and again; and they mentioned the sense of being in control. Other aspects highlighted were as follows:

- Access to online data to support fieldwork
- Immediate contact with parents of disruptive pupil
- One can retrieve the most up-to-date material
- I can learn while on the move
- multimedia modules on the fly
- To be able to read blogs while travelling
- Ability to carry different types of media
- Using “dead time/hostage time”
- Could log thoughts electronically
- To keep up with email and online discussions
- With headphones, more immersive than a book or video

When asked about the single biggest *disadvantage t*hat mobile devices bring them in relation to their learning, respondents mentioned issues of cost, privacy, and security or confidentiality of one’s mobile number. Technical or ergonomic issues were:

- Battery problems, lost files
- Device is unreliable, it jams, speakers are poor
- Lack of wi-fi in many locations
- Fiddly small screen, tasking on the eyes; best as audio devices

Interaction issues were also signalled:

- Easy to get distracted
- Text based message lacks inflection

- Lacking interactive multimedia
- Interaction can be clumpy and stilted
- Everything has to be short and small, how can we get any meaningful interaction
- Limit to the depth of thinking and learning

Interview findings

As mentioned earlier, a report on the follow-up interviews can be found in Pettit & Kukulska-Hulme (2006). One of the distinctive contributions of the interviews was to illustrate how the participants wove particular devices and practices into their daily lives, especially when travelling. The interviews indicate the particular importance of travel periods for study, for informal learning or for engagement with news and other material. They also highlight dependence on factors often outside the control of the individual. When participants chose or rejected a particular device, they cited a number of unpredictable factors such as changes to the design of buses or train seats, improvements in typing skills, whether a device 'looks stupid', or individual trade-offs about the value of carrying a larger device in order to gain a keyboard.

The interviews provided a particularly vivid account of the use of a moblog – where photographs were uploaded, news captured and discussions initiated. The interviewee spoke of the satisfaction of receiving positive feedback on photographs, and highlighted the role of individuals in capturing powerful and almost immediate images of the aftermath of the London bombings in July 2005.

Discussion

In this project, we were particularly interested in the types of activity undertaken, innovative or unexpected uses of mobile devices, and any issues mentioned by participants.

Our findings show that mobile phones were largely used for interpersonal activities including contact, coordination, interviews, as an alternative means of support and a means to motivate learners, but they also appeared to be personally useful as a practical tool and a reference tool. They could support some multimedia content and some forms of entertainment. Having additional functionality in a smartphone was associated with more options for communication, online resources and tools, the possibility to create and share simple content, and to synchronize with a PC.

PDAs came across as highly versatile tools that enabled access to a wide range of information; the preparation of materials; recording and tracking, including records of progress and achievement. They seemed to encourage various ways of holding or capturing small amounts of information, mindmapping and brainstorming, whilst also being suitable for larger files and databases. They supported administrative tasks and the use of typical Office applications, music files, multimedia content and news. Communication was a lesser feature of PDA use but there was mention of email, MSN messenger and web access to a discussion forum.

Mp3 players were widely used for entertainment but also turned out to be useful in a much wider range of activity, particularly in learning. In terms of receptive use, participants reported downloading podcasts, audio books, documentaries, lectures, conferences, interviews and other listening materials from the web. In more active mode, they recorded conversations, lectures and conferences, the BBC being a common source of material. With mp3 players, materials and listening exercises were sometimes distributed to students, and the voice recorder facility was used to capture students' spoken reflections on their learning. A connection with PC applications could be made by subsequently including audio files in a spreadsheet or Powerpoint. Participants were quite active in transferring files to other media, perhaps for the sake of

convenience: they copied audio courses and CDs onto their mp3 player and created mp3 files from Real Media lectures. The mp3 players were used as a backup, storage and transfer device and a means of sharing audio, video and photos. Although a favoured personal device, the mp3 player was also used in social ways, with the addition of speakers, to provide background music in workshops, to play sample music to clients and to play music to friends.

It seems that compared to other devices, the mp3 player was particularly conducive to creative and social uses that may not have been anticipated when we started this project, when mp3 players were largely perceived to be personal entertainment devices for private listening. Some activities are easily identified as new, for example a teacher using mobile devices to capture students' reflections on their learning, or the person who posts photos to a mobile blog and gets feedback from an online community. The 'newness' of the activity of course depends on whether it has been heard of before, which may be difficult to verify in relation to informal uses that frequently go undocumented. Other activities may be new, but in a less obvious way. From the nature of our data, it is difficult to determine the extent to which an activity performed with a mobile device might have been transformational, for example in that it constituted a new way of working for the individual concerned. Note-taking or mindmapping may seem like ordinary activities, but the possibility to perform them on a personal device that is used in situations involving mobility may significantly change the nature of what is noted and how. Unexpected uses include ways in which mobile devices may be used in conjunction with other technologies, for example the use of SMS during videoconferencing, or as an alternative medium when other avenues of support are (perhaps temporarily) unavailable.

In this project sample, the use of mobile technologies in connection with groups or communities was not at all widespread, which we had anticipated. Although the project

participants would all have had experience of online collaboration within the MAODE programme, the idea of using mobile devices to be part of a group or community was still relatively new in 2005. How rapidly this may change would be worth tracking through ongoing research. The extent to which mobile devices were already being used to browse websites was a slight surprise to us. The presence of activities relating to a foreign language (Greek, Japanese, Spanish) suggests that this may be a fruitful area for informal learning with mobile devices.

Issues brought up by questionnaire respondents related to some social aspects of use, travel, and technical problems. Depending on the context of use and the individuals concerned, texting may or may not be socially acceptable, and people may prefer to use their mobile phone in exceptional circumstances only or to remain always switched on and available. There appeared to be a clash between emerging mobile cultures (e.g. Virgin) and the preferences of a group of participants who may not see themselves as belonging to that culture. Mobile phone messages are typically very short and social, which may need to be considered when introducing more formal communication, e.g. between learners and an education provider. Spontaneous comments relating to use of PDAs were largely positive, with the devices keeping their users up to date and enabling productive use of time.

Technical issues surfaced in responses relating to PDAs (small screen, difficulties with blogs and conferencing) and mp3 players (poor microphone, awkward controls). Battery problems, lost files, reliability issues and lack of wi-fi in many locations were among the issues highlighted as disadvantages of mobile learning. These seemed to inhibit making best use of the devices but we did not ask specifically whether the problems were perceived as major ones or whether they had been overcome.

If we were to look for evidence, in common with Vavoula *et al*. (2004), that mobile devices were being used in ways that are more interactive and involve more contact, communication and collaboration with people, the high usage of text messaging is clearly important. However beyond that, the most frequent uses out of those proposed in the questionnaire were those that were largely self-contained, such as browsing websites, making notes, listening to audio and reading news. Participants expressed some reservations about the quality of interaction in mobile learning. Perhaps the fact that these are distance learning alumni with experience of high quality online interaction contributes to their behaviours and views.

Is it possible to say on the basis of this research that the ways in which participants are using mobile devices in work, social interaction and entertainment might have implications for teaching and learning? There were certainly many instances of general activities (e.g. action lists, notes, records, etc.) that may have been mentioned in relation to one sphere of activity but could easily be transposed into another. Mobile blogging was mentioned under ‘entertainment’ but blogs are general purpose tools that are currently being exploited in education. An entertainment tool such as an mp3 player was used for the more ‘serious’ task of recording and playback for conversation analysis. It seems that for an individual, it is largely a matter of coming up with the ideas and perhaps making the mental leap that takes one from seeing a device in one light to being able to use it in a different way altogether. The bigger question here is how do we enable people to discover the full potential of their mobile device? We may be moving away from a world in which the use of any new technology was associated with going on formal training courses in to order to become proficient at its use, towards a world where more informal learning will happen among colleagues and friends. Is a high level of comfort with mobile technology associated with increased personal innovation? And what are the best mechanisms for sharing

with others ideas for new ways of using mobile devices in teaching and learning? Future research must try to address these broader issues.

Conclusions

Our research confirms than amongst the participants of this study, mobile devices have indeed become commonplace tools serving a wide array of purposes that include teaching and learning alongside work and leisure. The education practitioners in this sample come across as active, sometimes experimental individuals, who are taking advantage of the capabilities of mobile devices to meet their own needs and the needs of their colleagues, clients and students. Our research connects with current interest in tracking teacher-led innovation, the focus of the UK Futurelab 'Teachers as Innovators' project which has set out to investigate where innovation is occurring in UK schools, factors contributing to innovation and methods for sharing and disseminating innovative practice with digital technologies (Sutch, 2006).

Thanks to mobile devices, learning appears to be occupying a new space that gives individuals the capacity to make use of electronic resources and tools in flexible ways that suit their circumstances and lifestyles. We have uncovered a vast range and diversity of ways in which a mobile device can be used to support different aspects of an individual's teaching and learning, and interactions with others. Since the devices are so personal, we think it is both challenging and important for educators and learners to find out how others are managing to use their mobile devices to help them in their teaching and learning. To enable this to happen, we need to find good ways of sharing and disseminating information about making effective use of the capabilities of mobile devices in education.

References

Ally, M. (2005). *Use of mobile devices in distance education*. Mlearn 2005 conference paper, Cape Town, 25-28 October 2005.

Belanger, Y. (2005). *Duke University iPod first year experience final evaluation report*, June 2005. Retrieved November 10, 2006, from http://cit.duke.edu/pdf/ipod_initiative_04_05.pdf

Berth, M. (2005). *Mobile learning – methodologies for the study of informal learning with mobile devices*. Mlearn 2005 conference paper, Cape Town, 25-28 October 2005.

Bradley, C., Haynes, R., & Boyle, T. (2005). Adult Multimedia Learning with PDAs – the User Experience. *Mlearn 2005 Conference Proceedings*, Cape Town, October 2005, 23-27.

Duke University (2006). *iPods enter Duke classes.* Center for Instructional Technology website. Retrieved November 10, 2006, from http://cit.duke.edu/ideas/newprofiles/ipod_faculty_articles.do

Edwards, R. (2005). Your employees are increasingly mobile, is your learning? *Mlearn 2005 Conference Proceedings*, Cape Town, October 2005, 50-52.

Fallahkhair, S., Pemberton, L., & Griffiths, R. (2005). *Dual device user interface design for ubiquitous language learning: Mobile phone and interactive television (iTV)*. IEEE International Conference on Wireless and Mobile Technology for Education (WMTE) in Tokushima, Japan.

JISC (2005). *Innovative practice with e-learning.* Case Studies. Retrieved November 10, 2006, from http://www.elearning.ac.uk/innoprac/index.html

Kukulska-Hulme, A. (2005). *Case studies of innovative practice.* JISC-funded project outcomes. Retrieved November 10, 2006, from http://www.jisc.ac.uk/whatwedo/programmes/elearning_innovation/eli_oucasestudies.aspx

Laouris, Y. (2005). *We need an educationally relevant definition of mobile learning*. Mlearn 2005 conference paper, Cape Town, 25-28 October 2005.

Leach, J., Power, T., Thomas, R., Fadani, X., & Mbebe, A. (2005). 4D Technologies: appropriating handheld computers to serve the needs of teachers and learners in rural African settings. *Mlearn 2005 Conference Proceedings*, Cape Town, October 2005, 95-102.

Manolo (2006). *Guidelines for integrating E-, W- and M-learning*. Project Deliverables – Mobile Case Studies. Retrieved November 10, 2006, from http://130.37.78.10/Projecten/Manolo/

Oksman, V. (2005). *Young people and seniors in finnish mobile information society*. Paper presented at the Symposium on Portable Learning – Learner and Teacher Experiences with Mobile Devices. The Open University, Milton Keynes, UK, 15 June 2005. Retrieved November 10, 2006, from http://kn.open.ac.uk/public/index.cfm?wpid=4378

Pettit, J., & Kukulska-Hulme, A. (2006). *Going with the grain: mobile devices in practice*. Ascilite conference paper, Sydney, 3-6 December 2006.

Rogers, E. (2003). Diffusion of Innovations. 5th edition. London: Free Press.

Scanlon, E., Jones, A., & Waycott, J. (2005). Mobile technologies: prospects for their use in learning in informal science settings. *Journal of Interactive Media in Education*, special issue on Portable Learning: Experiences with Mobile Devices, eds. Ann Jones, Agnes Kukulska-Hulme and Daisy Mwanza, 2005/25. Retrieved November 10, 2006, from http://jime.open.ac.uk/2005/25

Sharples, M. (1999). The design of personal technologies to support lifelong learning. *Proceedings of CAL '99 Conference on Computer-Assisted Learning*, London.

Sharples, M. (2005). *Re-thinking learning for the mobile age.* Kaleidoscope Network Viewpoint, posted on 5 October 2005. Retrieved November 10, 2006, from http://www.noe-kaleidoscope.org/pub/lastnews/default-0-read159-display

Spasojevic, M., Ito, M., Van House, N., Koskinen, I., Kato, F., & Okabe, D. (2005). *Pervasive image capture and sharing: New social practices and implications for technology*. PICS workshop position paper at Ubicomp 2005. Retrieved November 10, 2006, from http://www.spasojevic.org/pics/papers.htm

Sutch, D. (2006). *Teachers as innovators*. Futurelab project, October 2006. Retrieved November 10, 2006, from http://www.futurelab.org.uk/showcase/teachers_as_innovators/teachers_as_innovators.pdf

Traxler, J. (2005). Defining mobile learning. *Proceedings of IADIS International Conference on Mobile Learning 2005*, Malta, 261-266.

Vavoula, G. N. (2005). *D4.4: A study of mobile learning practices*. MOBIlearn project deliverable. Retrieved November 10, 2006, from http://www.mobilearn.org/download/results/public_deliverables/MOBIlearn_D4.4_Final.pdf

Figure Captions

Figure 1. Most frequent activities.

Running head: An Audio-Based Approach to Mobile Learning of Japanese Kanji Characters

An Audio-Based Approach to Mobile Learning of Japanese Kanji Characters

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Abstract

We describe the design and implementation of an audio-based computer system for mobile, non-visual learning of the meaning and writing of "kanji" characters: the thousands of multi-stroke Chinese characters used in the Japanese logographic writing system. Our system is designed for use by non-native learners of Japanese as a foreign language. The key feature of our system is its innovative use of a purely audio-based system for a learning task that is normally considered to be a primarily visual task (the task of learning kanji). By using a purely audio-based approach, our system allows mobile, any-time, any-place learning of kanji. This any-time, any-place learning capability is especially important because it greatly increases the ability of the student to review and practice kanji in mobile learning situations even while visual attention is not available. Evaluation results show that the instructional method used by our system leads to development of the memory skills needed for kanji fluency.

An Audio-Based Approach to Mobile Learning of Japanese Kanji Characters

Introduction

One of the most visually apparent features of the Japanese written language is its use of *kanji*, the logographic characters imported into Japanese from the Chinese written language. Students of Japanese as a Second Language (JSL) may have had no prior exposure to kanji; this is, in particular, likely the case if the JSL student's mother language uses an alphabetic writing system, as is the case with English. To attain written fluency in Japanese, the JSL student must learn as a starting point at least the few thousand kanji that are in daily-use in written Japanese. This typically presents a very difficult memorization task to the JSL student. To assist in this task, we developed a mobile system to allow the JSL student to review kanji anytime and anywhere by use of a novel audio-based approach implemented on a mobile platform.

In this paper, we first describe some background about the usage and learning of kanji. Next, we describe a popular kanji learning method - which we adapted for our system - laid out in James Heisig's textbook *Remembering the Kanji* (Heisig, 1986). We describe our adaptation of this learning method for audio-based mobile learning, present our implemented system architecture, and illustrate how our system fits into the overall kanji learning scenario. We present initial evaluation results, which confirm that our approach is effective in helping students remember the composition of complex kanji. Finally, we review related works, and conclude with directions for future work.

Background on Kanji and Written Japanese

Figure 1 shows a typical sentence in Japanese and its English translation. In general, written Japanese contains two types of characters, indicated in Figure 1 by overlining and underlining.

The first type of characters, marked in the figure with overlines, are called ***kana*** characters and are visually simple in form. They generally are used in written Japanese to show inflectional endings, conjunctions, or other grammar-related sentence structure. Kana can be learned by the JSL student in at most several days of effort, as there are less than 100 fairly simple kana symbols to learn.

The second type of characters, marked in the figure with underlines, are the ***kanji*** characters and are visually complex in form. They generally represent the semantic content of the sentence such as nouns, verbs, adjectives, and adverbs. Unlike the kana characters, kanji require much more effort to learn, due to their visual complexity and their sheer number. Although there are tens of thousands of valid kanji, the Japanese government has designated 1945 kanji, the so-called joyo kanji, as daily-use kanji. Japanese publications are generally encouraged to limit their usage to this list, though in practice more are used in printed matter, e.g. for proper nouns or special vocabulary. The minimum task for the JSL student, then, is to learn approximately 2000 daily-use kanji with complex forms. Because of the difficulty of this learning task, we are interested in mobile technologies that can help JSL students learn kanji characters.

For effective JSL kanji education, two concerns needs to be addressed:

1. What information should the JSL student learn about kanji?

2. How should the JSL student learn this information?

The answers to these questions influence the design of a mobile kanji learning system.

What the JSL student should learn about kanji

Learning each kanji requires a number of memorization tasks. For full written fluency, the student must learn the following for each kanji (Kano, Takenaka, Ishii, and Shimizu, 1990; Garnier and Mori, 1991).

Visual form

First, the visual form of the kanji must be committed to memory. Figure 2a shows a simple kanji character consisting of five strokes. The student must learn to recognize this form when it appears, differentiating it from potentially similar-looking characters. Furthermore, the student must be able to write this symbol from memory, recalling the necessary strokes.

Individual meaning

Next, the meaning of the kanji must be learned. One kanji may have more than one meaning. For instance, the kanji in Figure 2a by itself means “book,” or “main.”The kanji in Figure 2b means “sun.”These are the individual meanings of each the kanji. However, when combined, the kanji may change meaning, as shown below.

Compound formation and compound meaning

Individual kanji may be combined into a compound word, or compound kanji, as shown in Figures 3a and 3b. Combining the two kanji as shown in Figure 3a results in a compound kanji meaning “today”; however, combining the same two kanji in a different order shown in Figure 3b results in a compound kanji meaning “Japan”. The JSL student thus needs to learn valid compound formations and their meanings.

Pronunciation

Finally, the pronunciation of the kanji must be learned. Because the kanji characters were imported to Japan from the Chinese written language, each Japanese Kanji character generally

has at least two pronunciations. One pronunciation type is called the kun-yomi, and is the Japanese native pronunciation of the word corresponding to the kanji's meaning. The kanji in Figure 3a has a kun-yomi of “hon.” The other pronunciation type is called the on-yomi, and is the similar to the Chinese pronunciation of Chinese word corresponding to the kanji's meaning. The kanji in Figure 3a has an on-yomi of “moto.” There may be more than one on-yomi. Also, there may possibly be a nanori, a proper-noun pronunciation.

How the JSL student should learn about kanji

While there is little debate about *what* the JSL student needs to learn for kanji fluency, the question of *how* the JSL student should learn the information is debated (Richmond, 2005). Different textbooks take different approaches.

Figure 4 illustrates one style of learning, which we call a “depth-first” approach. In this approach, a student aims to learn everything about one particular kanji before proceeding to the next. This means that the student memorizes visual form, individual meaning, compound words and meanings, on-yomi, and kun-yomi for each kanji in sequence. Each kanji is learned "in depth" before moving to the next one.

Figure 5 illustrates another style of learning, which we call a “breadth-first” approach. In this approach, a student learns some information, such as meaning and writing only, for each kanji, then quickly progresses to the next. The aim is for the student to first learn some information about a very broad range of kanji, then later return to learn more deep information, such as pronunciations or compound words.

We believe the breadth-first approach is more effective, because it allows the student early on to quickly absorb a basic understanding of a large number of kanji. For our mobile

learning system, we based our approach on a breadth-first method proposed in a popular textbook by Heisig (1986), *Remembering the Kanji*.

Heisig's Method for learning kanji

Our system uses a modified version of the breadth-first method presented in James Heisig's textbook (Heisig, 1986). The method, because it is a breadth-first method, focuses only on how a student can learn the writing and meaning of the approximately 2000 daily-use kanji. It ignores issues of compound kanji or pronunciation, leaving these for later study.

Hierarchical component-based decomposition of complex kanji

Heisig's method combines simple kanji or parts hierarchically into more complex kanji or parts. Each kanji or part is assigned a unique name that also relates to its meaning. As noted earlier, one kanji can have more than one meaning, but this method chooses only one uniquely-named meaning for each kanji. The student therefore learns correct but possibly incomplete information about the kanji. This is in agreement with a breadth-first approach, where the emphasis is placed on quick learning of essential information for a large number of kanji, rather than in-depth study of all nuances of each kanji.

Figure 6 shows how simple kanji parts hierarchically combine to form a more complex kanji. The first row shows a simple visual shape, which is assigned a meaning of “cliff.” Because this shape is simple, it contains no smaller component parts. (Note: this particular shape is actually only part of a kanji character, not a complete kanji character, so it only appears as part of other complex kanji, and never appears as a complete character by itself. The shape thus carries no complete semantic meaning. Therefore, the meaning word assigned to this shape, “cliff,”is somewhat arbitrarily chosen from the shape's etymological origin.)

The second row in Figure 6 shows another simple visual shape, which is assigned a meaning of “mouth.” Though simple, this shape is a complete kanji and indeed means “mouth.” As before, because the shape is so simple, it contains no smaller component parts.

The third row in Figure 6 shows a visually more complex shape. Its meaning is “stone.” Compositionally, it can be viewed as being composed of the smaller shapes for “cliff” and “mouth.” Simpler kanji or parts therefore combine hierarchically to form more a more complex kanji. By extension, the kanji for “stone” also appears in other, yet more complex kanji.

Using this method, there are approximately 200 non-decomposable simple kanji or kanji parts; the rest of the kanji to be learned are combinations of these simpler parts.

Visual vs. Non-visual learning

The method of Heisig's textbook presents but does not emphasize learning of the visual form of the kanji (shown in the left column of Figure 6). Instead, focus is placed on learning the whole-to-part relationships (e.g. “stone” = “cliff” + “mouth”), which can be expressed verbally.

Figures 7 and 8 illustrate the difference between visual and non-visual kanji learning. Figure 7 shows a ubiquitous technique emphasizing visual memory, so-called “stroke order diagrams”(The Kanji Cafe, 2006). Figure 7 shows stroke order diagrams for three separate kanji. Each diagram is read left to right, and shows the order and placement of strokes necessary to compose a kanji visually. These types of diagrams appear in many kanji textbooks (e.g. Kano et al, 1990; Garnier and Mori, 1991) and imply that the student should devote a significant part of the learning effort to visual memorization of the shape and strokes of the kanji.

On the other hand, Figure 8 shows a representative excerpt from Heisig's textbook, which emphasizes non-visual memory. Of particular note is that, for the most part, there are no stroke order diagrams (though for early stages of learning some do appear early in the textbook).

Instead of a stroke-by-stroke diagram, there is simply an image of the kanji. The kanji image is primarily intended for use as a visual reference conveying the correct shape, not as an object in and of itself to be memorized. The real memorization work involves remembering the connection between the kanji meaning expressed as a word, and the names of the smaller parts making up that kanji. For example, the top kanji in Figure 8 is assigned a meaning keyword of "need," and is hierarchically decomposed into two shapes - the top shape being called "old west," and the bottom shape being called "woman." The next kanji, labeled "loins,"consists of the left shape, "part of the body,"and the right shape, called "need,"which is identical to and hierarchically builds upon the previous kanji. Therefore, instead of visually memorizing individual kanji strokes, the bulk of the student's memorization effort goes into memorizing more abstract verbal part-to-whole relationships.

Adapting Heisig's textbook method for audio-only mobile learning

For our mobile learning system, we decided that the textbook method of Heisig (1986), if extended and taken to its logical extreme, would have potential to allow mobile learning of kanji in a new way that had not yet been implemented by other kanji learning systems. The textbook displays but does not emphasize the visual aspect of kanji learning. Taking this further, for our mobile learning system we chose to completely eliminate all visual information. The result is a novel audio-only system for learning kanji writing and meaning.

Our audio-only method is possible because the the whole-to-part relationships of kanji shapes are expressed verbally, with unique keywords used for each kanji or kanji part. The verbal whole-to-part relationships can be conveyed with spoken audio. Of course, learning the visual form of kanji is necessary for ultimate kanji competency. Therefore our system is not

intended to replace textbook learning. Instead, our system is designed to complement textbook learning by allowing mobile review anytime and anywhere using the audio channel only.

Implementation of our mobile, audio-only kanji learning system

System architecture

Figure 9 shows our implemented system architecture and data flow. First, we constructed a text database of 2000 kanji meanings and parts. Next, we fed this data into an offline speech synthesizer, creating as output 2000 spoken audio files, each containing the spoken name of a kanji meaning, followed by a pause, followed by the spoken name of that kanji's component parts. These 2000 audio files were uploaded onto a Sharp Zaurus PDA mobile device, which played back the audio files in random order, repeatedly.

Learning scenario and system use

Our mobile system is intended to be used within the overall kanji learning scenario as shown in Figure 10. We divide the learning process into three stages.

Textbook learning is stage 1, shown at the top of Figure 10. During textbook learning, the student memorizes: (1) the meaning word associated with the kanji, (2) the names of the component parts making up the kanji, and (3) the visual form of the kanji.

Repeated review is stage 2, shown in the middle of Figure 10. This is the most time-consuming learning stage, intended to impress or confirm the impression of the learned information into long-term memory. This phase specifically is where our mobile system helps. After learning some number of kanji in stage 1, the student uses our system for constant, mobile review. First, the system randomly chooses one kanji from the database and speaks the word corresponding to the meaning of the chosen kanji, using audio-only output. Next, the system pauses for 4 seconds. During this pause, the student's task is mentally to try to recall the names

of the component parts of the kanji (illustrated in the Figure 10 by the thought bubble). Finally, after the pause, the system automatically speaks the names of the component parts making up the kanji. The student mentally checks if his/her answer was correct. The system then automatically repeats, and proceeds to the next kanji. In this way, the system provides continuous repeated review of the kanji meaning-to-part relationships.

Proficiency in kanji skills is stage 3, shown at the bottom of Figure 10. This last stage occurs after mobile learning and should reflect the kanji skills learned by the student. Since our system aims to assist in learning of only kanji meaning and kanji writing (using a breadth-first approach), the student should, after learning, be able to perform two kanji tasks:

a. Given a kanji meaning, recall its writing, and

b. Given a kanji writing, recall its meaning.

The two skills for the student to master are shown in Figure 10 as items 3a and 3b. They can be seen as related memory tasks, but in different directions. Figure 11 illustrates the memory tasks in more detail and graphically shows different the memory tasks as occurring in different directions.

The first memory task (Figure 10 item 3a, and Figure 11 arrows (1) and (2)), is: given the meaning word “need,” the student should be able to recall the written form of the associated kanji. Specifically, the student recalls the form by remembering the meaning-to-parts relationship that “need” is made up of “old west” plus “woman” (Figure 11, arrow (1)); then remembering the individual shapes for “old west” and “woman”; and finally writing the shapes for “old west” and “woman”, yielding the correct kanji shape (Figure 11, arrow (2)).

The second memory task (Figure 10 item 3b, Figure 11 arrows (3) and (4)), is related to the previous memory task, but requires recall in the opposite direction. In this case, the student is

given the kanji shape and must recall the meaning. In Figure 11, the student must identify the component parts of the kanji shape and remember their names (Figure 11, arrow (3)), which in this case are “old west” and “woman.” Then, remembering the learned association that “old west” and “woman” combine to form “need” (Figure 11, arrow (4)), the student finally recognizes that the given kanji means “need.”

Key features of system

A complement to textbook learning

Because our system provides no visual learning or feedback, it is not intended to replace textbook learning (phase 1), but instead complements learning with Heisig's textbook by assisting in time-intensive review learning (phase 2), enabling mobile, anytime, anywhere learning.

Audio-only modality

We use audio as the only output modality, not video. Specifically, we use audio of spoken words of the kanji meanings and part names. One key reason why an audio-only modality is possible is because of the uniqueness of words used for kanji meanings and parts. Every kanji meaning word or part name in Heisig's textbook is unique and is associated with only one visual kanji element. Therefore, because all of the spoken words are unique, there is no ambiguity in eliminating the visual kanji elements and expressing the kanji compositions purely verbally using spoken audio in our system.

Passive, non-interactive, heads-up system design

Our mobile system design is requires no input from the user. In terms of physical user interaction with the device, it is a passive system, not an interactive system. However, the system design incorporates a pause after the audio prompt to the user (Figure 10, phase 2), during which

the user is intended to mentally answer the query posed by the system. Therefore, though the system is physically passive, the system design allows the user to mentally interact.

On the one hand, this design decision means that the system has no opportunity to receive student input, so the system cannot evaluate student performance, which can be seen as a disadvantage. On the other hand, the passive design is an advantage, because it allows easy, continuous, repeated review of the material anytime and anywhere - all valuable features of a mobile learning system design. Particularly in the case of such a large memorization task as learning 2000 complex kanji, constant review is necessary, and we believe that our passive system design maximizes the mobile learning opportunities.

With our design, after starting the system, the student needs neither physical effort nor visual attention to continuously learn kanji in mobile and ubiquitous learning scenarios. Therefore, the system can be seen as a “heads up” system that can be used even if the user's visual attention is focused elsewhere. For instance, a student can constantly listen to our system in the background while cooking, riding a bicycle, or exercising - all tasks in which the user's hands and eyes are not available, and where other kanji learning systems would be impossible to use. With our system, the student only needs to focus aural attention on our system output, and mentally engage with the prompts and feedback of the system. If the user is temporarily distracted (by for instance a phone call), the system does not need to be paused: it can be simply ignored. When the student's aural attention is again available, the student can - with no loss of time or effort for system interaction - choose to focus on and benefit from the learning system, maximizing the benefit and minimizing the effort.

One-directional review method

A final point about our system design is that it uses one-directional review, not two-directional review. This means that the system gives the student a kanji name, then requires the student to remember the parts of the kanji needed to write it (Figure 11, arrow (1)). The system does not explicitly train the user in the opposite direction (Figure 11, arrow (4)). This is because we believe that training in only one direction saves time and does indeed lead to development of memory skills in both directions. The effectiveness of this teaching method was the subject of our evaluation.

Evaluation

Because our mobile kanji learning system uses an adapted version of Heisig's method, we wanted to evaluate the effectiveness of the method, to ensure student learning. The effectiveness of the method is measured by the acquired skill of the student. The desired skills a student should acquire after learning with our system are to be able to recall the writing (Figure 10 item 3a, Figure 11 arrows (1) and (2)) and to recall the meaning (Figure 10 item 3b, Figure 11 arrows (3) and (4)) of the learned kanji.

Although the student must ultimately learn both to recall the writing given the meaning and to recall the meaning given the writing, our system only explicitly drills the student in one direction, namely, recalling the parts necessary for writing given the meaning (Figure 11 arrow (1)). We do not explicitly drill the student on recalling the meaning (Figure 11 arrows (3) and (4)). This design decision runs contrary to many kanji learning systems (which explicitly drill the student in both directions), and was based on suggestions in Heisig (1986) - suggestions which, however, were only briefly mentioned and not supported with empirical data.

The evaluation question is as follows: does our design decision of drilling the student in only one direction (given meaning, recall writing) lead to learning of both of the necessary kanji

skills (given meaning, recall writing; given writing, recall meaning)? We hypothesize that the answer is yes. If the answer is yes, then we have evidence that our system makes effective use of the student's kanji learning time; if no, then our system is not training the student with sufficient kanji skills.

Simplifying assumption for evaluation purposes

Full kanji competency does require some visual learning; however, our argument, as stated earlier, is that the *majority* of learning effort need not go into visual memorization, but instead the *majority* of learning effort goes into learning the verbally-expressed whole-to-part relationships describing the hierarchical composition of kanji.

Based on this assumption, we further assume that learning effort required for the visual memory tasks in Figure 11 (arrows (2) and (3)) is small, compared to the learning effort required for the non-visual memory tasks (arrows (1) and (4)). Concretely: if, given a kanji meaning, the student has learned to recall the parts, then the additional learning effort required to then recall the writing is relatively small. Similarly, given a kanji's visual form, recalling the part names of the visual components is relatively easy; the harder, more voluminous, and more important task is remembering the kanji meaning associated with the part names.

Therefore, for our evaluation, we made the simplifying assumption of ignoring the learning effort necessary for arrows (2) and (3) in Figure 11; these steps are drawn inside of dashed lines to indicate that we ignore them during evaluation.

Referring to Figure 11, our simplified evaluation question then becomes: does training in direction (1) lead to development of memory skills in both direction (1) and direction (4), as is needed for kanji competency?

Evaluation Method

To conduct our evaluation, we implemented a WWW-based training and memory quiz as follows.

Participants

Anonymous participants were recruited by an electronic message posted to selected USENET forums. The recruitment message stated that subjects were desired for a web-based experimental quiz testing language and memory. A URL to the WWW server running the experiment software was given. Over a one-month period, sixteen participants responded to the message and completely participated in experiment.

Procedure

We implemented a WWW-based training and quiz program accessible via a WWW browser. The quiz program would first train users to memorize kanji meanings and parts. Then, the program quizzed their memory with a fill-in-the-blank quiz. We conducted two conditions for the experiment.

Condition 1 (9 subjects) was named "remember meaning." This condition does *not* correspond to the teaching method used in our system. There were three parts to this condition. First, the subject was given a kanji meaning and its component part names (Figure 12). The subject was instructed to memorize *only* the meaning, and to be able to recall the meaning given the parts. Ten such kanji were presented to the user for memorization. Second, the subject was given a fill-in-the-blank quiz on the memorized information. Given the parts of a kanji, the subject was required to fill-in-the-blank of the kanji meaning (Figure 13). Third, the subject was given a surprise quiz in the reverse direction. Though the subject was not asked to memorize this information explicitly, the subject was asked to fill-in-the-blanks for the kanji parts, given the

kanji meaning (Figure 14). The purpose of the surprise quiz was to test if learning implicitly took place in the opposite direction than was learned. Referring to Figure 11, the subject explicitly learned in the direction of arrow (4), was quizzed in direction of arrow (4), then as a surprise had to also recall information in the opposite direction of arrow (1).

Condition 2 (7 subjects) was named "remember parts." This condition corresponds to the teaching method used in our system. As before, there were three parts to this condition. First, the subject was given a kanji meaning and its component part names (Figure 15). The subject was instructed to memorize *only* the part names, and to be able to recall the part names given the meaning. Ten such kanji were presented to the user for memorization. Second, the subject was given a fill-in-the-blank quiz on the memorized information. Given the meaning of a kanji, the subject was required to fill-in-the-blanks of the kanji part names (Figure 16). Third, the subject was given a surprise quiz in the reverse direction: the subject was asked to fill-in-the-blank for the kanji meaning, given the kanji parts, to test for any implicit learning effects in the opposite direction (Figure 17). Referring to Figure 11, the subject explicitly learned in the direction of arrow (1), was quizzed in direction of arrow (1), then as a surprise had to also recall information in the opposite direction of arrow (4).

Evaluation Results

We evaluated the number of questions correctly answered for each condition, in both the memorized direction and the opposite direction. The results appear in Table 1.

The ability to recall information in the direction explicitly memorized was higher in condition "remember meaning" (47%) than condition "remember parts" (24%). However, the opposite is true when recalling in the opposite direction. The ability to recall information in the direction *opposite* that explicitly memorized was lower for condition "remember meaning"

(22%) and higher for condition “remember parts” (71%). Finally, overall memory performance, in both the memorized and the opposite direction, was lower for condition “remember meaning” (35%) and higher in condition “remember parts” (48%).

Discussion

We interpret our experimental data as follows. First, subjects learning meanings could recall the learned information better than subjects learning parts could recall the learned information. We attribute this to the greater inherent difficulty of learning the part information.

Second, however, explicitly learning parts given meaning did lead to good memory in the opposite direction, recalling meaning given parts. This was not true for subjects who explicitly learned meaning given parts. This shows that the effort put into the more difficult task of learning parts given meaning also leads to implicit learning of meaning given parts. In Figure 11, this means that explicitly learning in direction (1) implicitly leads to learning in direction (4) as well, but the reverse is not true. This is also reflected in the total memory performance in both directions (third column of Table 1), which was better for students who explicitly learned parts rather than those who explicitly learned meaning.

It should be noted, however, that this online memory quiz lasted approximately half an hour for each participant, therefore using short-term memory and not long-term memory. However, learning 2000 kanji for language fluency, through repeated review using our mobile kanji learning system, is a long-term memory task, not a short-term memory task. Nevertheless, we still believe that the results of a long term memory experiment would be similar to those of this short term memory experiment, and that the conclusions we can draw from the results still stand.

In conclusion, the data supports our hypothesis that focusing learning effort in the direction of “given meaning recall parts” leads to acquisition of memory skill in both the direction “given meaning recall parts”as well as the direction “given parts recall meaning.” Therefore, the learning approach offered by our system is an effective use of the student's time and leads to the necessary recall skills for kanji competency.

Related Work

We are not aware of other work which uses spoken audio and a component-based approach as in our system. For instance, KanjiGym Light (Grunewaldt and Rauther, 2006) is a computerized review program designed for students using Heisig's textbook. Given a randomly selected kanji meaning, the student must write the kanji using the mouse in an empty on-screen window. The system then displays the correct writing, and the student then clicks on “yes” or “no” to indicate if their response was correct or not. In contrast to our audio-based system, KanjiGym Light requires active use of the student's hands and eyes during the entire learning process.

KDrill (Brown, 2006) is a multiple-choice flash-card program written for desktop PC's. It allows quizzes in both directions: given a kanji image, the student must recall the meaning; alternatively, given a kanji meaning, the student must recall the kanji image. It does not quiz students on the whole-to-part component relationships within a kanji. It also quizzes the student on compound kanji, which we specifically decided to omit from our system. KDrill, like KanjiGym light, again requires use of the student's hands and eyes during the learning process.

In contrast to our sensorially-minimal audio-only approach, a sensorially-rich approach is taken by Wagner and Barakonyi (2003), who present an augmented-reality system for learning kanji, using hand-held displays and kanji cards on a table. A hand-held display acts as a magic

lens; when the display is physically held in front of a card containing a kanji character, the display shows an augmented reality image of an object corresponding to the kanji's meaning. The described system only works with ten kanji cards, and likely would be difficult to scale up to work with the 2000 kanji needed for native-level kanji study; in particular, the optical pattern recognition software would likely have difficulty differentiating 2000 kanji shapes, many of which are visually very similar. Also, the system visualizes concrete kanji representing nouns, such as “car” or “tree”; on the other hand, it is not clear how more abstract kanji could be visualized as objects (e.g. kanji representing states of mind, actions, and so forth). Finally, the focus on visual object representations for the kanji indicates that this system is intended for different learning scenarios from those of our mobile audio-only system.

Some handheld electronic Japanese-English dictionaries offer component-based indices to allow component-based lookup of individual kanji characters. (Atarashii Jisho, 2003). However, such dictionaries do not provide a quiz function for the kanji components; furthermore, the component information is not expressed in spoken-audio form as with our system, and thus again requires use of the student's eyes and/or hands. Also, such dictionaries are typically intended for use by native Japanese speakers or advanced JSL students who already have a firm grasp of kanji, whereas our system targets beginning JSL students with limited kanji skills.

Regarding the breadth-first learning method of Heisig's textbook, there has been to our knowledge only one academic investigation of this method, by Richardson (1998). Richardson attempted to outline the theoretical underpinnings of the method, and also adapted the method for the Chinese language. However, Richardson specifically did not attempt to assess the effectiveness of the method: “I did not empirically test either Heisig’s [method] for the learning

of kanji or my Chinese adaptation of his [method]. My interest was that of extending the examination of relevant theoretical and empirical issues..." (Richardson, 2003). Our evaluation data therefore provide new empirical support for the effectiveness of a one-directional learning and review method.

Conclusion and Future Work

We presented a novel audio-based system for mobile learning of kanji. In contrast to almost all other kanji learning systems and books - which assume that visual attention must be used during all stages of learning kanji - our system challenges that assumption and teaches the writing of kanji through part-to-whole relationships using spoken words and an audio-only modality. This allows mobile kanji learning anytime and anywhere. With our system, in contrast to other kanji learning systems, students can review kanji even when hands or visual attention are not available.

Our system uses a one-directional review method. Given a kanji meaning, students are prompted to recall the kanji parts; the other direction is not drilled. We evaluated the effectiveness of the one-directional learning strategy and found that it does lead to acquisition of memory skills in both directions needed for kanji competency.

Future work includes long-term user studies using the system for extended periods of time, and evaluating not only memory of the kanji part-to-whole relationships as we did here, but also the actual long-term kanji reading and writing skill acquisition of the student.

References

Atarashii Jisho (2003). Retrieved November 14, 2006 from http://www.densijiten.co.jp/column/column.php?column_id=20030910

Brown, P. (2006). *KDrill info page*. Retrieved November 14, 2006 from http://www.bolthole.com/kdrill/

The Kanji Cafe (2006). *Stroke Order Diagram Editor-Retrographer (SODER) Volunteer Project*. Retrieved November 14, 2006 from http://kanjicafe.com/using_soder.htm

Kano, C., Takenaka, H., Ishii, E., and Shimizu, Y. (1990). *Basic Kanji Book*. Japan: Bojinsha Co., Ltd.

Garnier, C., and Mori, T. (1991). *Japanisch ohne Muehe* (German-language edition, D. McEwan, Trans.) France: Assimil.

Grunewaldt, L., and Rauther, R. (2006). *KanjiGym Light*. Retrieved November 14, 2006 from http://www.kanjigym.de

Heisig, J. (1986). *Remembering the kanji I: A complete course on how not to forget the meaning and writing of Japanese characters*. Tokyo: Japan Publications Trading Co., Ltd.

Richardson, T. W. (1998). *James W. Heisig's system for remembering kanji: An examination of relevant theory and research—and a 1,000-character adaptation for Chinese*. *Dissertations Abstracts International 59(06A), 2002.* Bell and Howell Information and Learning [formerly UMI] Publication No. 9838097.

Richardson, T. W. (2003). *Comments on a Dissertation Dealing with James W. Heisig's Approach to Kanji memorization*. Retrieved November 14, 2006, from http://www.kanjiclinic.com/richardson.htm

Richmond, S. (2005). A re-evaluation of kanji textbooks for learners of Japanese as a second language. *Journal of the Faculty of Economics, KGU, Vol. 15, July 2005*, 43-71.

Wagner, D., and Barakonyi, I. (2003). *Augmented Reality Kanji Learning*. Proceedings, The Second IEEE and ACM International Symposium on Mixed and Augmented Reality, Tokyo, Japan.

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Table 1

	could recall memorized direction	***could recall opposite direction***	***total recall***
Condition 1, remember meaning	47% (43/90)	22% (20/90)	35% (63/180)
Condition 2, remember parts	24% (17/70)	71% (50/70)	48% (67/140)

<u>Results of memory quiz</u>

Figure Captions

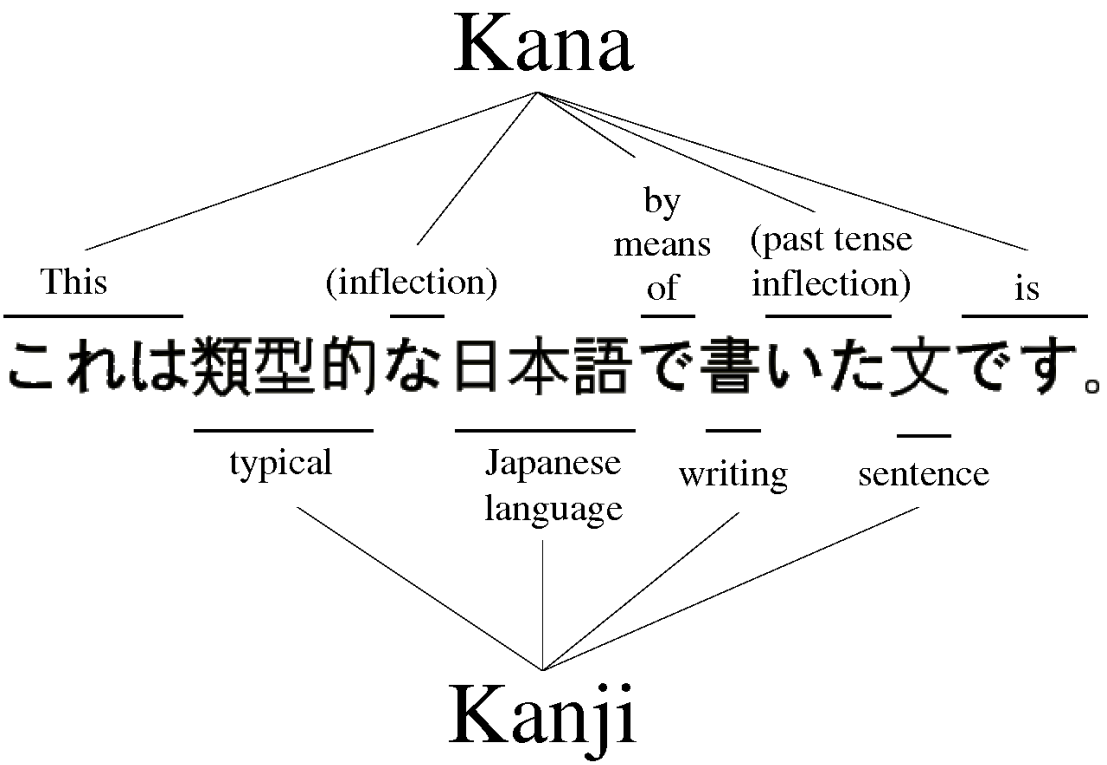

Figure 1. A typical written Japanese sentence, illustrating kana and kanji characters.

a.	本	book; main
b.	日	sun

Figure 2. Individual kanji characters. (a) Kanji character meaning “book” or “main”. (b) Kanji character meaning “sun”.

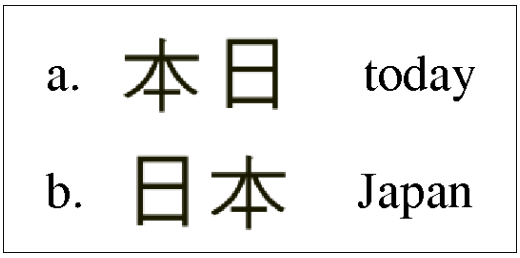

Figure 3. Kanji compounds. (a) A compound kanji meaning “today”. (b) A compound kanji meaning “Japan”.

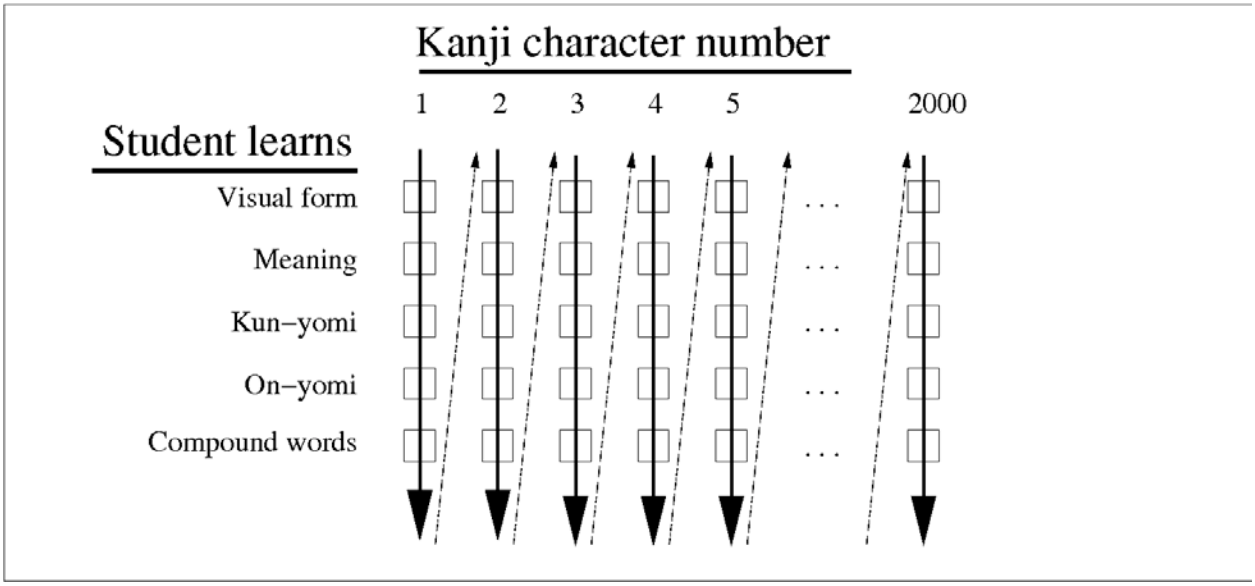

Figure 4. Depth-first approach to learning kanji.

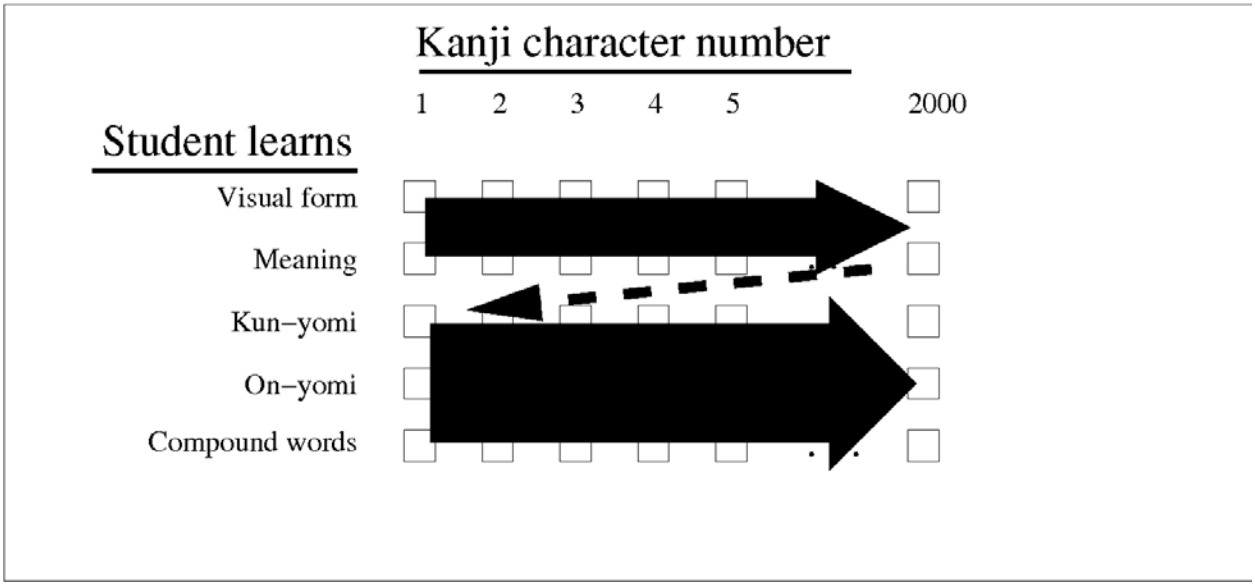

Figure 5. Breadth-first approach to learning kanji.

VISUAL	MEANING	PART NAMES
厂	cliff	(none)
口	mouth	(none)
石	stone	cliff, mouth

Figure 6. Simple kanji parts hierarchically combine to form complex kanji.

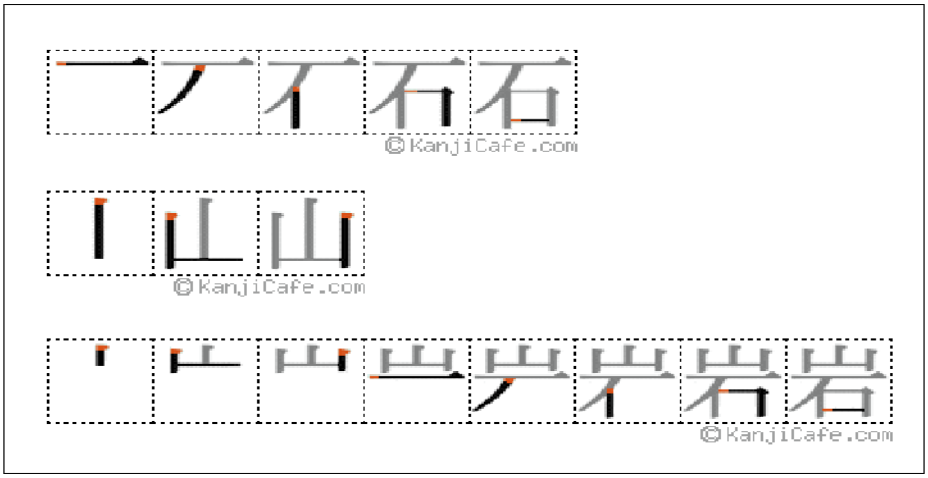

Figure 7. Visual learning of kanji shapes with stroke-order diagrams (The Kanji Cafe, 2006).

1604 要	*Old West . . . woman.* [9]	need
1605 腰	*Part of the body . . . need.* [13]	loins
1606 票	*Old West . . . altar.* [11]	ballot
1607 漂	*Water . . . ballot.* [14]	drift
1608		signpost

Figure 8. Non-visual learning of kanji shapes with verbal whole-part relationships (Heisig, 1986).

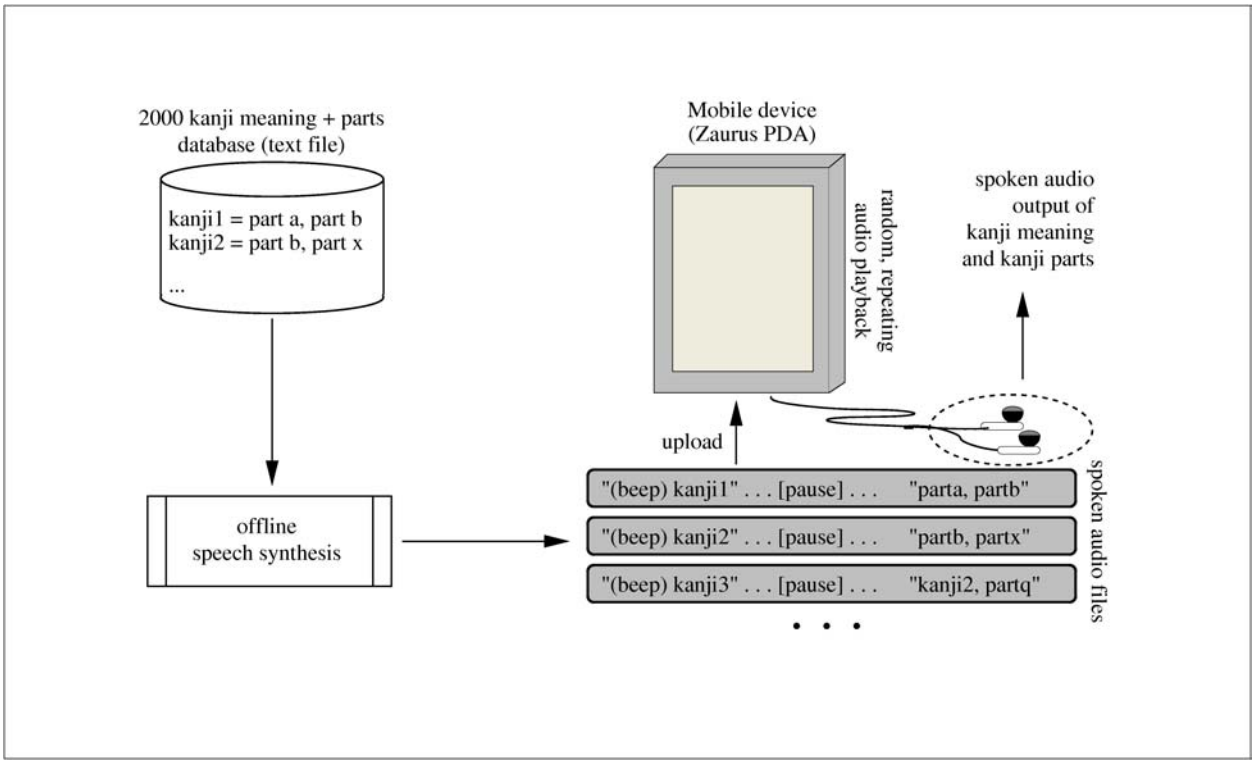

Figure 9. Architecture of mobile, audio-only kanji learning system.

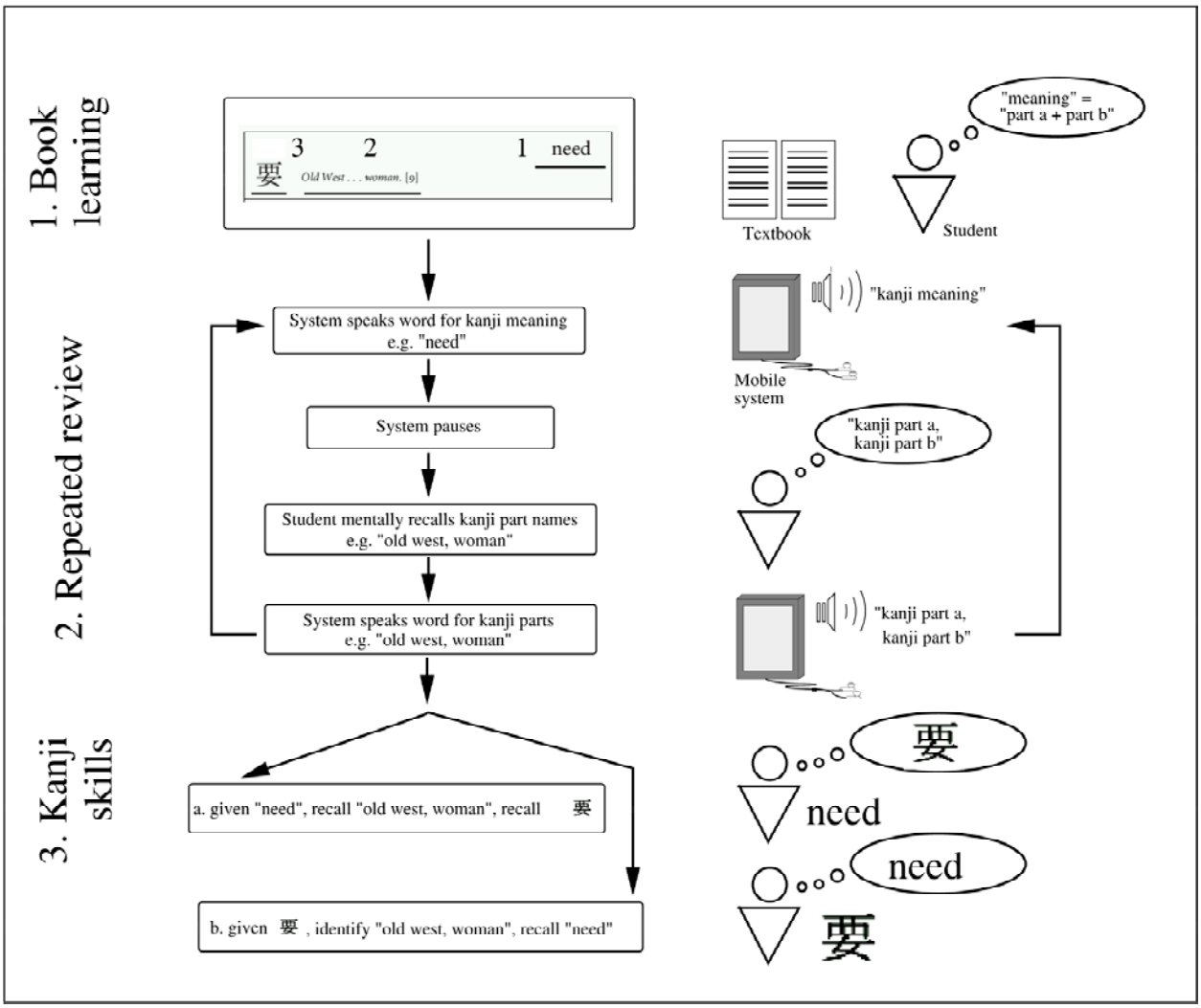

Figure 10. Role of mobile learning system in overall kanji learning process.

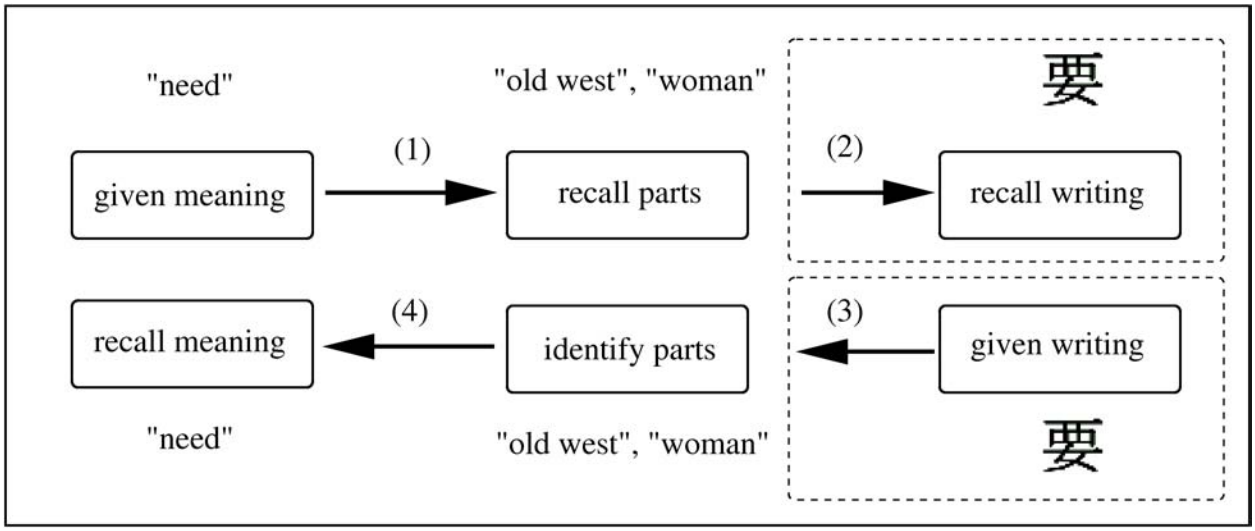

Figure 11. Kanji skills to be learned by the JSL student, in two directions. Dashed lines indicate skills not included in experimental evaluation.

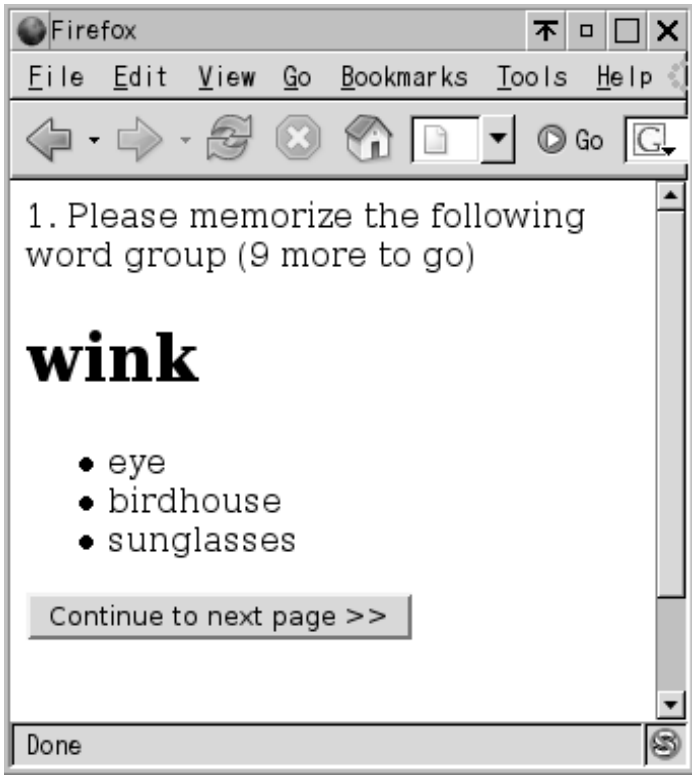

Figure 12. Evaluation: web-based quiz, learning phase (condition “remember meaning”)

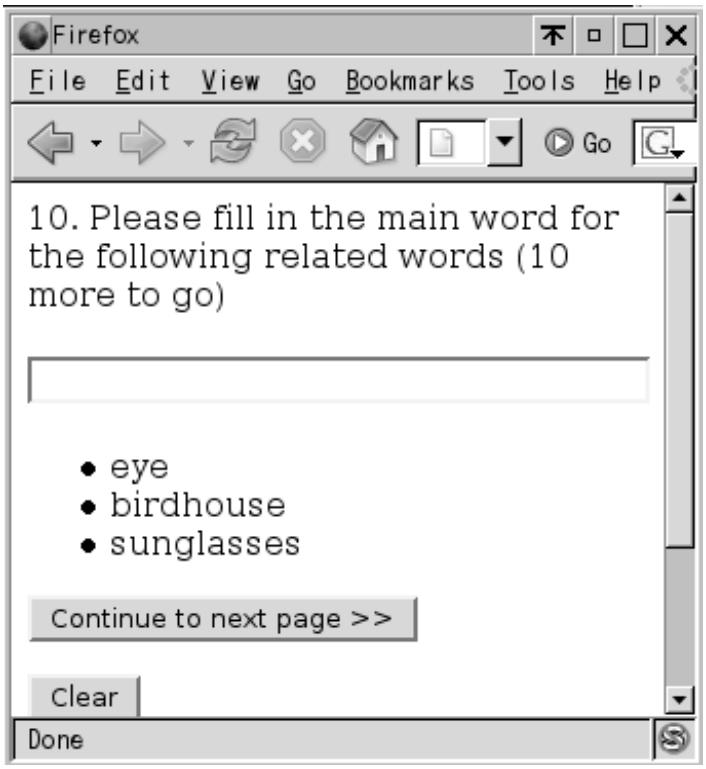

Figure 13. Evaluation: web-based quiz, normal quiz phase (condition “remember meaning”)

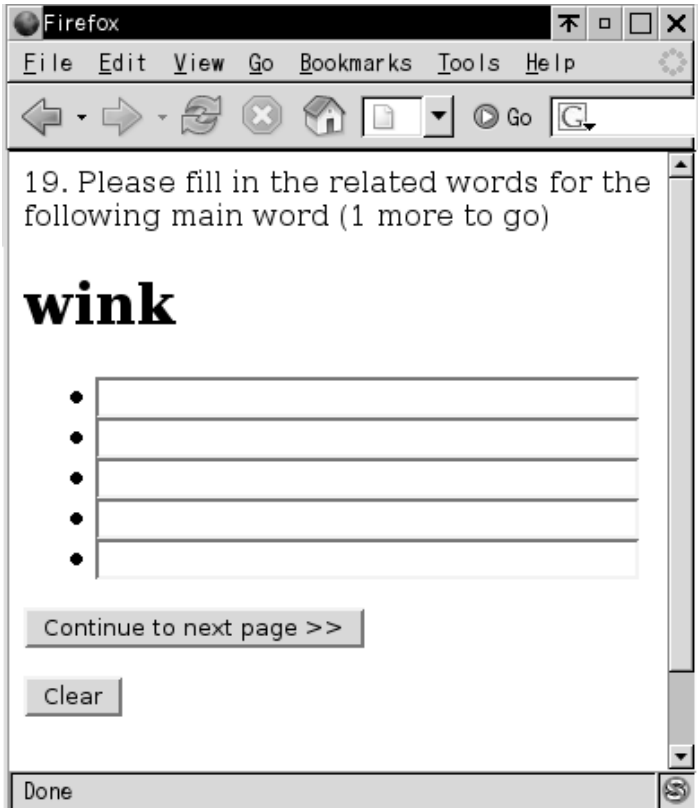

Figure 14. Evaluation: web-based quiz, surprise quiz phase (condition “remember meaning”)

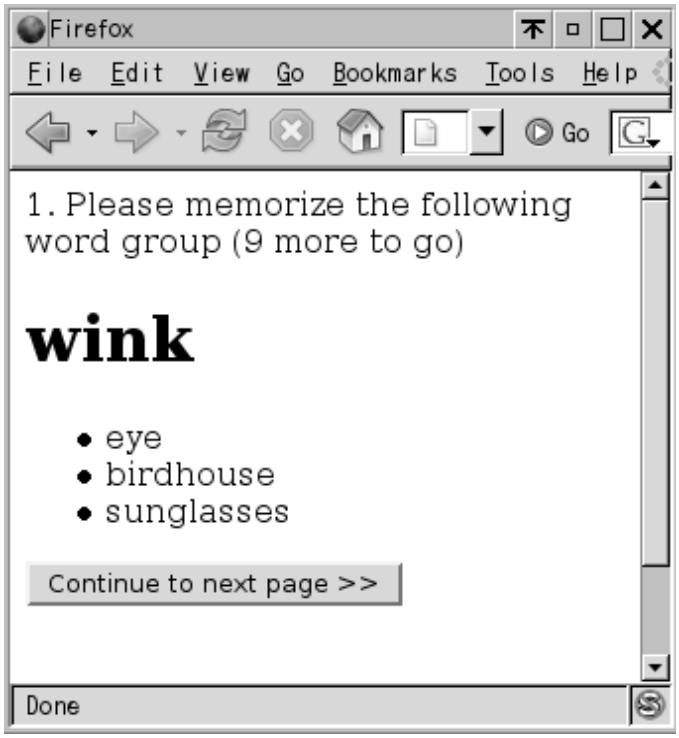

Figure 15. Evaluation: web-based quiz, learning phase (condition “remember parts”)

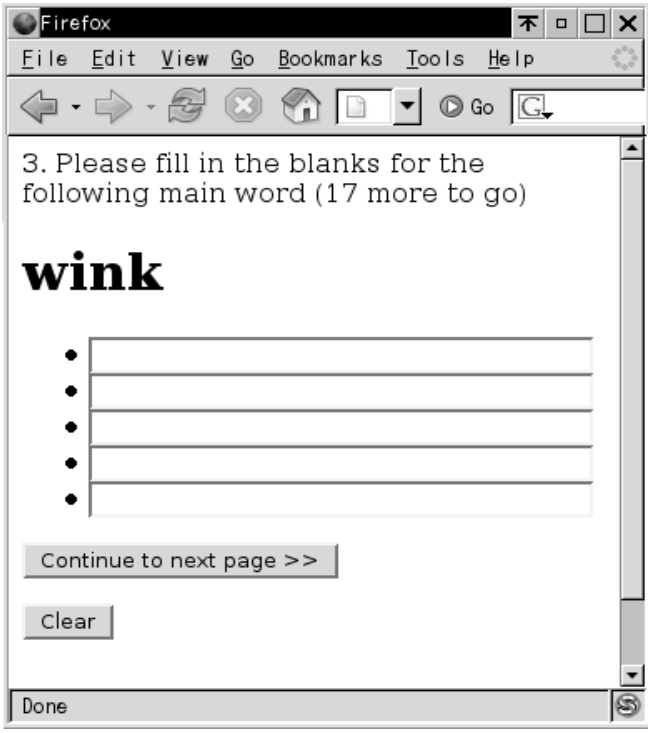

Figure 16. Evaluation: web-based quiz, normal quiz phase (condition “remember parts”)

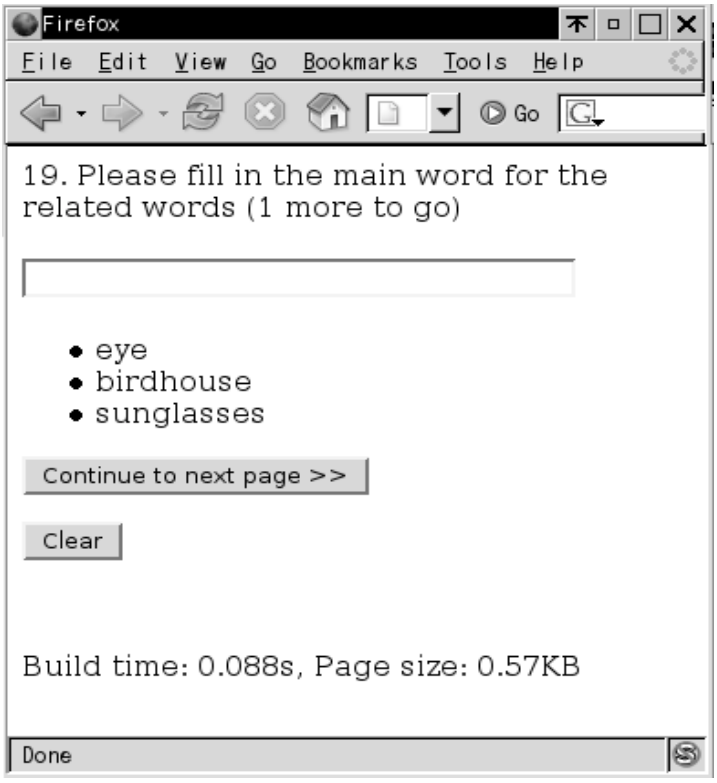

Figure 17. Evaluation: web-based quiz, surprise quiz phase (condition “remember parts”)

Mobile Technology in Facilitating Learning Goals

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Abstract

Mobile and wireless computing technologies have influenced how people interact with each other. For the first time, mobile technology and student lifestyle choices are converging to allow mobile learning (m-learning) to be a viable choice for delivery and execution of coursework material. This study looks at the current research on how asynchronous technology, such as discussion boards, can be enhanced by enabling students to interact with a mobile device. A synthesis of the literature is presented, analysing the issues that may impact on the success of this project and any limitations that may impact on the value of this application. This paper then discusses the advantages of enabling a discussion board with particular focus on whether enabling students to interact with a mobile device will increase the participation and success of discussion boards.

1. Introduction

The world we live in is increasingly fast-paced and communication is ever-present. In this world, students require the ability to learn anywhere at anytime. Mobile learning (m-learning) delivers this requirement. M-learning is emerging as a pedagogical revolution which provides students with autonomy and the mobility to learn. The mobility of education is achieved with the use of mobile devices such as personal digital assistants (PDAs), smart phones and tablet PCs. The aim of this technology is to utilise the portability which mobile devices offer, combining it with a rich interaction enabling students to learn at a level previously unattainable.

Tools used in learning that offer collaboration between students are of great interest to educators, as their effectiveness tends to be interaction-dependent and thus sensitive to limits of face-to-face accessibility among educators and students. Discussion boards can be utilised as a tool for asynchronous group collaboration among geographically dispersed participants as they offer many benefits to users. The main benefit that discussion boards offer is that they facilitate the construction of low-level learning up to and including high-level evaluative skills (Weasenforth, Meloni, and Biesenbach-Lucas, 2000). Discussion boards, characterised by long response lags, allow students to develop more articulate and critical responses (Salmon 2000). Conversely, these long response lags may also adversely affect the level of interactivity of the participants. Long delays between messages limit creativity and motivation of students to continue interacting. The speed and level of interaction within a collaborative group are therefore associated and often reliant on the technology used to facilitate the collaboration (Hill, 2001).

Online threaded discussions seem particularly well suited to mobile enhancements given that their effectiveness depends heavily on active participation and timely posting/response cycles (Hill and Roldan, 2005). Mobile technology provides a vehicle for involving threaded discussions that better emulate face-to-face discussions by enabling interaction, in device-scaled form, between the participants in real time wherever they are (Hill and Roldan, 2005). Thus, discussions are not confined to the desktop, allowing dynamic and immediate communication that can take place anywhere, taking the paradigm from ‘pull’, beyond ‘push’, to a ‘reach’ orientation (Hill, 2003).

2. Collaboration and learning

The asynchronous discussion mechanisms, such as discussion boards, draw on group interaction to encourage collaborative learning styles. Students learn through interacting with other students to help develop and confirm their understanding of the information. The role of the teacher is to help facilitate this interaction to help students build their own knowledge. Communication between students is more transitive in nature; communication is two-way, active and dynamic, therefore knowledge is conducted rather than just received from the teacher (Pea, 1994). This type of collaborative style can be helped through the use of a computer-mediated discussion board.

Studies in this area have shown that there are two main arguments supporting collaborative learning (Benbunan-Fich & Hiltz, 2003; Cross 1998; Webb, 1982). The first argument for the use of collaboration in learning is that students, who learn within groups, be it a small group or the whole class, have less anxiety and uncertainty. Students are able to verify and cement their learning through communication with other students. This, in turn, helps improve motivation and satisfaction of students and helps the general learning process (Benbunan-Fich & Hiltz, 2003).

In addition to the above argument, collaborative learning helps students develop an active learning environment over a more passive teacher driven environment (Cross, 1998). Communication and learning is created and developed by students who bring new views and opinions and students are able to develop their own understanding through this sharing of ideas. Learning is therefore an individual responsibility and students are accountable for their own learning (Johassen, 1994; Jones & Issroff, 2005).

3. Traditional Discussion Board

Computers enable easier collaboration between students, enabling them to interact without constraints of time or place. This is especially important for students who are physically distributed (Benbunan-Fich & Hiltz, 2003; Harasim, Hiltz, Teles, & Turoff, 1998).

Asynchronous online interaction such as discussion boards leads to new paradigms for learning. Students are allowed to collaborate and communicate with each other more easily than would be possible in an offline environment (Harasim, Hiltz, Teles, & Turoff, 1995). Studies have shown that students may achieve a higher level of understanding compared to more traditional methods, such as in-class discussions (Benbunan-Fich & Hiltz, 2003; Hoyt, 2000; Sheard, 2004). This maybe due to the fact that students do not need to respond immediately to messages, which they would have to in a synchronous environment either online or offline. Students are able to think about the queries and even utilise the wider resources that are available online to respond with answers that are better thought out and add more value to the discussion than they would be able to if the replies were needed to be given straight away (Mason & Kaye,1990).

Asynchronous communication also allows for an equal foundation for all students no matter if they are physically handicapped, are less dominant and tend to be introverted, or have low language ability, which may affect face-to-face or synchronous communication (Benbunan-Fich & Hiltz, 2003). Students may feel more comfortable presenting information than they would in a face-to-face situation (Swift, 2002).

Tools such as discussion boards enable additional feedback for teachers and allow them to monitor and track student's discussions (Swift, 2002). Discussions are therefore more robust and thoughtful, as students know that the discussion is recorded and teachers have a better idea of student's understanding of concepts (Swift, 2002).

One of the major issues with the use of discussion boards in learning is that often participation among the students is low. Even though access to the discussion board is available to students all the time, it is often not utilised or the quality of participation is minimal (Hoyt, 2000).

3. Where Mobile technology aims to fill in the gap

The main idea behind collaboration is that it is based on interaction that is dynamic and of a high quality. Students are busy and usually have a high workload and many other commitments. For students to use a discussion board they first need to see it as a beneficial tool for the completion of their studies and it should be easy to use and not take a large amount of student's valuable time. Enabling students to interact with a mobile device allows them to communicate anytime and anywhere no matter their schedule and where they happen to be located; students are no longer tied to the desktop computer but are able to get valuable, timely information when and where they need it.

Enabling students to interact with mobile devices allows them to access messages as they are posted; the messages do not get old and students are able to keep up-to-date with the current discussion. This, therefore, helps in maintaining momentum in the discussion (Hill & Roldan, 2005). Facilitating students with the ability to check messages easily and more frequently, a mobile device eliminates the accumulation of unread messages. Students no longer need to wade through large volumes of unread messages that are not valuable because they are not relevant any more.

Giving students the facility, which enables them to interact more conveniently, should increase participation. Increased participation should then directly influence the level of learning on the discussion board (Benbunan-Fich & Hiltz, 2003; Hoyt, 2000; Sheard, 2004). Since students will be able to access posts as they are posted, this should in turn decrease the time that they take to respond and increase interaction. Having said this, the discussion board will not lose the advantage that students still have a chance to take time preparing a well thought out response that traditional discussion boards offer (Hill & Roldan, 2005).

Interaction between students can be instantaneous. Students can choose to interact immediately if they are available and wiling to engage. If the timing is right a critical mass can develop sparking a lively synchronous debate (Hill, 2003). Therefore mobile devices offer the advantages of allowing communication that can be both asynchronous and synchronous.

According to Chen, Ko, Kinshuk & Lin (2005), enabling the discussion to have the flexibility to take place synchronously in addition to asynchronously offers the following additional benefits for students: immediate feedback and increased motivation. Immediate feedback allows students to strengthen their learning by being able to immediately correct wrong or ill thought out assumptions, which are needed in group decision-making, brainstorming, and analysis. In addition, synchronous discussion motivates students to participate as there is a compulsion to be present and participate which in turn would increase students involvement in learning activities, hence resulting in better learning experiences.

The responsiveness of participants in the discussion will impact on the overall success of the discussion board. Low response will lead to a decline in use as users develop a "responsive image" (Tyler & Tang, 2003). This means that students develop an impression of the overall responsiveness of the discussion and mirror the level. A minimal level of activity eventually leads to minimal levels of postings. Students who post regularly maybe discouraged by the slow rate of participation and may be less inclined to check posts regularly; if a reply is posted quickly it may not be checked till later further impacting the level of interaction. Interaction on mobile devices should eliminate this as students will be notified of new posts to questions and they will be able to access new posts immediately with the option of also replying immediately (Hill & Rolan, 2005).

The use of mobile technology can also be used to help generate critical thinking. Intelligent agents can be used to prompt users to stimulate and enhance the discussion (Hill & Rolan, 2005). The higher activity of students along with wider participation, and decreased time between posts should better allow for a more enhanced learning experience.

4. Issues with using mobile technology

Though mobile devices offer a better learning environment, a number of limitations do affect the success of this technology. The following discusses some key limitations that relate to trying to enable asynchronous discussions to take place on a mobile device.

Small screen size
One of the major advantages of mobile technology is the size of the device. To be fully portable, mobile devices have shrunk and have become ubiquitous. This advantage can often cause a problem when trying to use mobile devices in the learning context. Mobile devices are not typically designed to enable learning, bigger devices, such as PDAs are aimed at the business-orientated market and are not totally suited to supporting learning (Savill-Smiths Kant, 2003). The small screen size limits the amount of text that can be seen easily and long posts may require a high amount of scrolling. In addition, it is hard to show how messages are connected if there are a large amount of messages linked to one discussion. (Cheng & Gruen, 2003). Typically on a PDA a 95mm, 240-by-320 pixel screen is approximately one-sixth the size and one-fourth the resolution of a 380mm, 640-by-480 standard desktop monitor (Comerford, 2000). Most Web pages are designed to be displayed using desktop computers with large screens and are of a higher resolution.

Fortunately, the future looks a little brighter with the advent of mobile television. Mobile devices are being introduced with increasing functionality and bigger screens, making screen size an issue that may be resolved partly if not fully in the near future.

Difficult input mechanisms
Inputting text is often slow and difficult on a mobile device, so long messages maybe discouraged (Viehland & Marshall, 2005). This may impact on the quality of discussion. Therefore, to counteract this, mobile interaction should be looked as more to enhance interaction and not to replace traditional discussion boards accessible from desktop computers.

Decreased storage capacity and bandwidth
Large content can often cause problems when sending it between mobile devices (Lee, Yamada, Shimizu, Shinohara, Hada, 2005, Stone, 2004). Mobile devices often have a slower download speed, hence the discussion board will need to be designed to enable fast uploads and downloads.

Cost of interaction
To view and interact with the discussion, participants will need to connect to the Internet or send text messages. It is often difficult and expensive to access ordinary web pages. Most websites are distorted on a mobile device and multimedia is often lost. The discussion board will need to be designed with the aim that it will also be viewed using a mobile device. This maybe difficult when working with a dynamic website such as a discussion board (Shudong & Higgins, 2005). Therefore the design of a discussion board must be taken into account with an understanding that the discussion must be accessible from both a traditional desktop computer and a mobile device without limiting or impacting interaction on either device.

Language versions
Currently very few mobile devices can support a wide range of languages, often limited to English and the user's mother language (Shudong & Higgins, 2005). This issue should not be critical at the moment as often discussion boards are only available and interacted in one language but if the discussion board is used in a language course this may become an issue.

Standardisation and compatibility
To be truly effective, a discussion board should be able to be accessed from a wide variety of mobile devices (Lee et al, 2005).

Future research and conclusion

The use of mobile devices as a means of interaction on a discussion boards offers many key advantages, but for this to be feasible the issues mentioned above need to be overcome or limited. A mobile device can offer students a rich form of interaction and not limit the students from interacting only when they are in front of a desktop computer. Students can access information and develop a social connection when they want to and how they want. Mobile devices can enhance students learning by offering them a more effective, useful learning environment.

References

Benbunan-Fich, R. and Hiltz, S., R. (2003) Mediators of the effectiveness of online courses [Electronic version]. *IEEE Transactions On Professional Communication*, *4*, 298-312.

Chen N. S., Ko H.-C., Kinshuk & Lin T. (2005) Synchronous Learning Model over the Internet. *Innovations in Education and Teaching International*, 42 (2), 181-194 (ISSN 1355-8005)

Cheng, L. and Gruen, D. A Mobile user interface for threading, marking, and previewing email. IBM Technical Report 03-08, 2003.

Cross, K., P. (1998). Why learning communities? Why now? [Electronic version]. *About Campus*, 3, 4-11.

Comerford, R. (2000) Handhelds duke it out for the Internet, *IEEE Spectrum Journal*, 37, 8, 35-41.

Harasim, L., Hiltz, S. R., Teles, L. and Turoff, M. (1995*) Learning networks: A field guide to teaching and learning online*. Cambridge, MIT Press.

Hill, J. R. (2001) Building community in web-based learning environments: Strategies and techniques [Electronic version]. *Seventh Australian World Wide Web Conference*, NSW, Australia, AusWeb.

Hill, T.R. and Roldan, M. (2005) Toward third generation threaded discussions for mobile learning: Opportunities and challenges for ubiquitous collaborative environments. *Information Systems Frontiers*. 7(1) p 55-70.

Hill, T.R. (2003) Leveraging mobile technology for m-learning: 3rd generation threaded discussions. *Proceedings of the 36th Annual Hawaii International Conference on System Sciences, 2003*. San Jose State Univ., CA, USA;

Hoyt, B.R. (2000) Techniques to manage participation and contribution of team members in virtual teams [Electronic version]. *WebNet Journal*, 4, 16-18.

Jones, A. and Issroff, K. (2005) Learning technologies: Affective and social issues in computer-supported collaborative learning [Electronic version]. *Computer and Education*, 4, 395-408.

Lee, I., Yamada, T., Shimizu, Y., Shinohara, M., & Hada, Y. (2005). In search of the mobile learning paradigm as we are going nomadic. In Kommers, P., & Richards, G. (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2005* (pp. 2888-2893). Chesapeake, VA: AACE.

Mason, R., and Kaye, T. (1990). Toward a new paradigm for distance education. In L. M. Harasim (Ed), *Online Education: Perspectives on a New Environment* (pp. 15-38). New York: Praeger Publishers.

Pea. R. (1994). Seeing what we build together: Distributed multimedia learning environment for transitive communication [Electronic version]. *Journal of Learning Sciences*, 3, 285-299.

Salmon, G. (2000). E-Moderating: The key to teaching and learning online. London, Kogan Page.

Savill-Smith, C. & Kent, P. (2003). The use of palmtop computers for learning LSDA, London.

Sheard, J. (2004). Electronic Learning Communities: Strategies for Establishment and Management [Electronic version], *ITiCSE 2004*, 28-30.

Shudong, W., and Higgins, M. (2005). "Limitations of Mobile Phone Learning," *Wireless and Mobile Technologies in Education. WMTE 2005. IEEE International Workshop on* , vol., no.pp. 179- 181, 28-30 Nov. 2005

Swift, E. (2002). Enhancing collaborative learning [Electronic version]. *Business Communication Quarterly*, 3, 29-41.

Stone, A. (2004). Designing scalable, effective mobile learning for multiple technologies, Jill Attewell and Carol Savill-Smith (Eds.). (2004). *Learning with mobile devices: Research and development. Learning and Skills Development Agency (LSDA).* Pp.145-153

Tyler, J., and Tang, J.C. (2003). When Can I Expect an Email Response? A Study of Rhythms in Email Usage, *in Proceedings of the European Conference on Computer Supported Cooperative Work* (ECSCW 2003), ACM Press.

Viehland, D., and Marshall, J. (2005) The effectiveness of PDAs for enhancing collaboration in M-Learning. *Proceedings of the Eleventh Americas Conference on Information Systems*, Omaha, NE, USA.

Weasenforth, D., Meloni, C. and Biesenbach-Lucas, S. (2000) Impact of asynchronous electronic discussions on native and non-native students' critical thinking. In *Proceedings of Learning On Line 2000: Reassessing the Virtual University*. Roanoke, VA: Virginia Tech.

Webb, N. M. (1982). Student interaction and learning in small groups [Electronic version]. *Revised Education Resources*, 3, 421–44.

Using Games, Mobile and Wireless Environments to Construct Meaningful and Motivating Learning

Two Cases: Adventure in the Castle of Oulu (1651) and Virtual Snellman (1822)

Jukka Miettunen, Pasi Mattila

Abstract:

The traditional notion of a learning environment has expanded to cover virtual spaces. Today, these virtual learning environments are often network-based and readily wireless accessible to a certain group of students. Virtual meeting places are extremely popular among young people. Their very popularity can occasionally even present problems in everyday schoolwork. Thus, attempts to harness these new tools and environments for learning purposes are worth undertaking.

These considerations have inspired the present project that has produced a 3D virtual learning environment with the aim of providing a space for learning activities. The space itself and its virtual inhabitants in these cases are based on historical data. The players who enter this environment learn by interacting with the characters and each other.

The game offers challenges the players try to solve as a team. It emphasizes group work skills, group interaction, and cooperation in various conflict situations that have to be negotiated inside the virtual world. Historical information plays a key role in game play and thus the learning experience is integrated to the events of the game, making learning fun. The environment utilizes both verbal and non-verbal communication and it does not contain violent or destructive elements and therefore it is suitable for children of all ages and both sexes.

One of the important goals of realizing the Snellman game is to make sure the application can be transported to other networks and is able to utilize different learning environments through, for instance, mobile devices. The use of mobile technology raises a number of questions in terms of production. How central a role should mobile devices assume in game play? In what way should information acquired via mobile devices mesh with the virtual environment?

1. Introduction

The game concepts were produced in cooperation with the Department of Education of the City of Oulu and Ludocraft, the Game Design and Research Unit of the University of Oulu led by Dr. Tony Manninen.

This article describes two projects whose aim was the creation of a virtual space designed to enhance learning. The activities embedded in this virtual space offer a game-like environment that supplies the players with bits of information which carry the plot of the games and provide an interactive learning experience. The convergence of gaming and learning environments expounded through the description of these

projects challenges traditional notions of teaching and learning, changes the way these concepts are viewed, and creates an alternative perspective to the distribution of information. Briefly, the examples are the following:

Case I: Adventure in the Castle of Oulu

-historical environment based on the ancient castle of Oulu in the year 1651
-virtual environment with a maximum of 30 participants
-3D game engine, allows verbal communication between participants via headsets

Case II: Virtual Snellman

-J. V. Snellman, a historical statesman, father of the Finnish currency
-an open virtual network environment
-includes tools for mobile technology applications

1.1. Gaming Technology for Educational Purposes

1.1.1. Youth Culture and Social Change

Young media consumers want to be active participants in rather than passive observers of information. This is particularly apparent in their use of the Internet – they are at home in networks and virtual environments. Previously, the Net was conceived merely a source of information, but today the social and communal nature of virtual network environments is recognized. Information is actively constructed online through the exchange of opinions and images. Furthermore, users want to be able to influence their virtual environment and not only act as consumers but as producers of information as well. In the learning environments of the future users will be able to manipulate content to suit their present needs. These developments, in turn, will present challenges to individual schools as well as pedagogy in general.

Young students are constantly applying new technologies creatively to suit their own purposes. According to the Scandinavian eLearning Nordic (2006) study, the use of information technology does improve learning results. The problem with new technologies is that teachers often feel unqualified to apply them to teaching. Teachers and students inhabit different digital worlds and this mismatch is reflected on the learning experience. The effective use of information technology requires a departure from traditional teaching methods and available pedagogical frameworks.

1.1.2. Games as Viable Learning Environments

Games and play are natural activities and part of everyday life. Before the advent of mobile and wireless technologies games were tied to specific occasions and locations. Today, games are capable of producing a forum where people can establish and uphold relationships with others. The societal role of games is transforming gaming from a mere pleasure-seeking activity into an incremental part of modern society, especially in youth culture.

People use games as a means of expression. Gaming is a phenomenon that touches nearly everyone. Games and game environments provide a space wherein one can

solve problems, interact with others, and build social networks. They also present opportunities for exploring and developing one's emotional life. Furthermore, as shown by Gee (2003, p. 205), games operate with solid principles of learning that are better than those in many of our skill-and-drill, back-to-basics, test-them-until-they-drop schools. Games are often multilayered and can contain a vast variety of activities, address any number of interests, and provide countless possibilities for human interaction. In the future, it is crucial to develop genuinely innovative educational games for large audiences in order to counterbalance the mass of violent games on the market. As such, games will have an increasingly important part to play as learning environments and methods of teaching (cf. Lim et al. 2006).

1.1.3. Using Games to Construct Meaningful and Motivating Learning Situations

Earlier research has suggested that games can have a positive impact on learning, since they support intrinsic motivation, and give opportunities for imitation and learning by providing feedback, fantasy, and challenges (Rieber 1996). The purpose of play is to practice everyday skills. In order to motivate the player, a game must have a goal. This goal produces a challenge for the player and motivates him or her to develop the skills that are required to reach it. Digital games fulfill the central requirements of purposeful play (Ermi et al. 2004). Learning need not be the explicit objective of play, but any given game requires some learning to take place. The charm of play and the popularity of digital games inevitably lead to the question: Can gaming be used in teaching? Through games, children are often prepared to go to great lengths in order to achieve their goals.

Playing games develops one's style of thinking towards an experimental, game-like approach to problem solving. The activities that take place within a game are circumscribed by a set of rules that have been agreed upon beforehand (Salen and Zimmerman 2004). In addition, the game acts as a learning space in which the learner is able to take risks where real-world consequences are lowered (Gee 2003, p. 62).

Online games and various virtual game environments are steadily gaining in popularity. Gaming is as much a hobby as reading books, but often this is not recognized by parents. Children are especially attracted to action and adventure games. Furthermore, children more often than not resort to their circle of friends in their choice of games and thus gaming is at the outset a social affair. Young students view games as meaningful and motivating environments that enable them to exercise their faculties, actively explore various subjects, meet with friends, and create and uphold relationships with others. In contrast, most parents and educators view games as entertainment.

This framework is the basis on which the present research on virtual learning environments in Oulu has been built. The Department of Education of the City of Oulu and the university's game research unit have produced two projects in which it has been possible to observe the benefits of educational gaming in practice. The following two cases provide information and discussion about the value of gaming in education. The cases consist of two games that bring history to life.

Figure 1: Bird’s eye view of the area surrounding the Castle of Oulu

2. CASES

2.1. CASE I: ADVENTURE IN THE CASTLE OF OULU (1641)

Educational Gaming Technology: an Experiment in Design and Application

2.1.1. Background

In 2005, the City of Oulu celebrated its 400th birthday. The very same year, the city hosted an event known as the Festival of Schools and welcomed 12,000 school children and teachers from all over the country to participate in activities associated with the event. One the largest workshop at the Festival was dedicated to communication and media skills and the workshop needed something new and exciting to attract students. This need was met by designing an educational 3D gaming environment.

Figure 2: Gamers in action

Research on the application of virtual environment technologies to education has been pioneered in the University of Oulu by the Research Unit for Educational Technology at the Department of Educational Sciences and Teacher Education with the leadership of Professor Sanna Järvelä. In this work, game design and development have been the responsibility of the university's game research unit, LudoCraft, led by Tony Manninen. These efforts have focused mainly on higher education and they have been documented in various publications (see, for instance, Hämäläinen et al. 2004, Hämäläinen et al. 2006, Manninen and Korva 2005). Drawing from this research, the present project aimed at developing students' communal skills in a virtual environment as well as exploring further advancements in the field.

2.1.2. Realization and Pedagogical Objectives

2.1.2.1. Production and Design Team

The team in charge of the realization of the project consisted of a game development group of eight people who supplied all the essential skills required for designing and constructing a game. The team was lead by a producer and a lead designer. Among the areas of expertise of the participants were programming, level design, 3D modeling, animation, audio design, script writing, graphical design, and concept art, to name a few. With this approach, it was possible to acquire the required level of quality for the outcome of the project.

The game development team was supported by a group of pedagogical experts who planned the functional and educational features of the game and made sure it met the needs of players aged 9 to 16 years. The seamless collaboration between game developers and pedagogical experts enabled the project to harness two very different knowledge bases.

2.1.2.2. Platform

The platform chosen for the project was the Unreal game engine by Epic. An end user license agreement of €50 per workstation secured the use of the platform for non-profit, research, and educational purposes. A client version of the Unreal environment was installed to a number of workstations which were then connected to a server that controlled the flow of the game. Most modern PCs with adequate memory and a competent 3D graphics card can perform these tasks.

2.1.2.3. Game and Gameplay

The virtual game environment emphasizes group interaction and cooperative skills, testing these skills in various challenging conflict situations that have to be resolved through teamwork. The game itself is a multiplayer game designed for up to 30 simultaneous players. It should be noted that the objective of the designers was to avoid the inclusion of any violent or destructive elements in order to ensure the applicability of the game for educational aims and younger players.

The environment is a faithful representation of the area surrounding the Castle of Oulu in 1651. The model is based on historical documents and drawings from that period. Some fictional elements were added to enhance gameplay.

The moderator sets up the game on the server according to the age and number of participants, assigns a preferred duration for the game, and adjusts the difficulty level. Each player is assigned a name, a character, and a specific mission. The assigned characters are based on typical professions and social classes of the period such as peasant, clergyman, merchant, or soldier. A typical mission statement reads: "You are a shopkeeper and your job is to buy and trade as much merchandise as you can. In addition, you have to contribute to the mayoral campaign of the merchant Anders Mattson by acquiring votes." The other players receive similar tasks associated with various professions. Some of the players act as henchmen, creating discord and thus adding suspense to the game. The players score points according to their performance on a given mission. The teacher, acting as moderator, can assume the likeness of a bird or a dog in order to move freely in the environment as an observer.

The user interface of the game is simple and straightforward. Movement in the game environment is controlled by the arrow keys on the keyboard and the computer mouse. Exchanging items and other related actions take place using the function keys.

Figure 3: Players exchanging microknowledge via headsets (voice data), characters sporting speech bubbles

Communication within the game is conducted with the aid of headsets. Contact in the virtual game world is established by approaching a character at which time a speech bubble appears and signifies the possibility for communication. Communication via natural speech instead of the usual written chat-form was found to be a major strength of the game. However, this required some special arrangements in the game room as it produced the need to create sound proof areas for the players. The practical solution to this problem was to erect cubicles – like in many language-learning studios – for individual workstations.

A typical session consisted of the following activities:

-demonstrating the basic idea and principles behind the game 15 min
-playing the game 60 min
-feedback and discussion 15 min

2.1.3. Observations

The objective of the project was to investigate the educational use of a 3D gaming environment targeted for students 9 to 16 years old. Given the relatively short amount of time that was available for design and production, the game itself can be considered a success. Despite the fact that before the final field experiments the game had not

been tested on large groups involving more than 10 players, the game environment was found to be stable and reliable.

Over 300 students took part in the ten separate game sessions during the week of the Festival. In addition to oral and written feedback, gameplay was videotaped and recorded on the computers' hard drives. This material is currently under analysis by the research group.

Preliminary findings based on the oral and written feedback suggest that a game-like approach to historical materials is motivating for the students. As with the use of print or following learning material in multimedia form, assuming a character in a virtual world can act as a valuable supplement for the learning process.

New teaching programs often emphasize community, the importance of communication, and media skills. The game showed potential for the realization of precisely such objectives.

This pilot project did not contain the elements required for an in-depth study (such as the use of a control group) and therefore its conclusions must remain tentative. However, the project did produce a wealth of data that can be used to benefit future research.

At present, the environment is freely available for student groups through the Department of Education of the City of Oulu.

2.2. CASE II: VIRTUAL SNELLMAN (1822)

Figure 4: A street scene from Snellman’s period

The positive feedback from Adventure in the Castle of Oulu inspired the team to conceive of a second educational game. Unlike in Adventure in the Castle of Oulu in which gameplay took place in a closed environment coordinated through client programs, the game's follower was designed to function on the Internet and contain the possibility of interfacing with other learning environments and technologies such as mobile devices. The 3D game engine software created for the project was designed with future projects in mind.

This section describes only the designing process and the early stages of production. The finished product will be available for schools in the fall of 2006.

2.2.1. Background

The year 2006 marks the 200th birthday of J. V. Snellman, a legendary Finnish statesman and philosopher who acted in several political roles during his lifetime. The theme of the jubilee is to celebrate the national identity of Finland and this theme is illustrated through the colorful personal history of Snellman himself. All citizens and especially the younger population are encouraged to participate in various events that take place throughout the year.

Virtual Snellman, a virtual learning environment situated in the year 1822, is part of these pursuits. The central idea behind Virtual Snellman is to create a virtual learning environment that contains a wealth of information about Snellman and his contemporaries, and to transport the player into their historical surroundings. The learning environment will also contain exciting game-elements such as various objectives and goals, role-playing and colorful characters, and an exciting plot. Students will be able to develop strategic thinking as well as problem solving and decision making skills. Furthermore, the learning environment will enable the student to be a part of a group and interact with his or her social network.

This Snellman-themed learning environment will be realized as a game in order to attract students. The purpose of the game will be to introduce the students to fascinating historical materials in an exciting way and thus make the learning experience a captivating one.

A game-like environment will offer the player the opportunity to shape the learning experience to suit his or her interests. A game that emphasizes action will make the relationship between the individual player and the information imparted by the game an active process in which interaction and communal goals are raised above the gathering of factual knowledge.

2.2.2. Objectives

The objective of the Snellman project is to construct a virtual learning environment that is inspiring and rich in opportunities. The learning environment contains a wealth of information which is contextualized in the form of a virtual world. Learning in this environment occurs by exploring the virtual space, problem solving, and interacting with others.

Figure 5: A learning environment containing microcontent

2.2.2.1 The Core Questions of Content Production

In the design stages of the Snellman game, the following central questions have to be addressed before and during production:

1. What does a game have to be like in order to attract and maintain the interest of the target audience?
2. What kind of control mechanism is suitable for the target audience in a 3D environment?
3. How to utilize the enormous amount of historical data in a manner that does not transform the game into a mere reading experience?

2.2.3. Interfacing

One of the important goals of realizing the Snellman game is to make sure the application can be transported to other networks and is able to utilize different learning environments through, for instance, mobile devices. The use of mobile technology raises a number of questions in terms of production. How central a role should mobile devices assume in gameplay? In what way should information acquired via mobile devices mesh with the virtual environment?

How much do the locations of buildings in present-day Oulu differ from the year 1822 and can disparate materials acquired through the use of mobile devices be utilized in the first place? Could one utilize mobile devices in ways other than gathering

information about locations in present-day Oulu? Should this information play a central role or should it remain an added feature?

2.2.4. Requirements

During pre-production, the requirements and demands of the target audience have been carefully mapped. In addition, the design group has compiled a list containing technical requirements for production, content, game design, audiovisual style, and the storyboard.

2.2.4.1. General Properties

The Snellman game was assigned the following properties:

1. A virtual environment where the action takes place
2. Three dimensional, modular, visually impressive
3. Content respectful of the theme
4. Interfacing: mobile devices, other systems

2.2.4.2. Requirements Relating to Gameplay

The following chart illustrates a preliminary list of requirements for a viable game.

Requirement	Arguments and Examples
Replayability	Must not lack in content even if played through a number of times
Expandability	Possibility to expand the environment in the future Sequels, further levels and scenarios
Rich in relevant information	Full of interesting details about Snellman’s life Not merely an encyclopedia
Visual appeal and ambiance	Competent audiovisuals attract young gamers Able to convey factual knowledge to the target audience
Educational	Exploration, observation, analysis Not only performance but atmospheric as well
Appealing to young gamers	A genuine game, not a mere application Goals, challenges, and rewards must be clearly visible
Easy to learn	Everyone should be able to play the game Low threshold, but challenging enough

2.2.4.3. Activities in the Environment

The learning environment consists of virtual spaces where the activities take place and information is imparted. A virtual space might be a room, the scene of an historical event, or some other space that contains the necessary selection of tools, characters, and activities.

-creating the space and circumstances
-modeling the events
-setting up the objectives and related activities

-emphasizing interaction

Virtual model of the city center

-an environment the user can explore freely
-information, observations, and materials located in (say) a printing press
-a space where the user can store information

2.2.4.4. Information

The educational objectives of the Snellman game set demands for the historical information present in the game environment. Despite its game-like qualities, information conveyed by the environment takes center stage. However, the objective of the project is not to produce a Snellman databank. The information presented in the game can be viewed as both raw material for gameplay and educational material for students.

1. Information must be based on historical facts
    (a) A critical approach to sources
    (b) Ensuring the authenticity of the material
2. There must be a sufficient amount of information
    (a) Collecting, recording, and transforming the material into a presentable form
    (b) Arranging the material into suitable blocks
3. Information must be accessible
    (a) The material must be placed into the game environment
    (b) Interactivity
4. Information must be presented in an interesting manner
    (a) Game-like qualities
    (b) Choosing perspectives and the manner of presentation

Proper presentation of the information requires that the environment is modeled after Snellman's era; specifically, the year 1822. The objective of designing the learning environment is to create a virtual space that contains all the relevant information. This information is based on historical fact, arranged in a suitable manner to cover relevant topics, easy to approach, and presented in an exciting way.

The game is intended mostly for younger gamers and therefore the information must not be in textbook or encyclopedic form. The user must be able to experiment, explore, and engage the subject matter in a vivid manner. Creating these effects through various activities and experiences can be achieved by faithfully modeling Snellman's era and being true to its historical features.

2.2.4.5. Information Created by the User

Content created by the users themselves is a current topic that has generated lots of interest in gaming and virtual communities. The reason for the popularity of this feature of gaming can be explained by the individual user's desire to star in his or her own storyline and leave a mark on the given environment.

-information is generated collectively
-question and answer wiki
-conversation and interaction with other players

-A user-specific registered character makes it possible for him or her to voice opinions, address questions, to leave signposts for future gamers, and discuss observations about gameplay with others; this makes the information presented in the environment yet more meaningful.

-The user can submit acquired information to his or her own e-mail account for future use or augment a previous answer given in response to a problem presented by the game at a later date by using (say) an entry code supplied by the game.

Content created by users can also present significant risks. If the content is not controlled in the proper manner, there is a danger that the environment will be filled with inappropriate materials.

3. Utilizing Games for Educational Purposes: A Summary of the Project

The two case projects described in this paper approach the problematic area of educational games with a hands-on mentality. Since an educational game cannot deliver if either the educational content or the game itself fails, there is a need to combine the two domains into a seamless multidisciplinary effort The two-year collaboration between pedagogical experts and game design researchers has provided us with a wealth of information – and critical questions – that can be used in future work.

How to present information to young students in a meaningful and exciting way? How to bring books to life? Snellman, for instance, has been the subject of a biography exceeding a thousands pages and a 24 volume series of books, consisting of 12,000 pages. Young students do not favor written materials of this sort. Is it possible to deliver the same information using games?

The learning process involved in gaming often proceeds in concordance with gameplay. Games require and develop various problem solving faculties and learning strategies. Children associate learning with the classroom situation and thus games offer, as it were, a covert way of delivering information. The idea behind microcontent is to offer the players information that one could acquire from a textbook and present it in small bits, embedded in the virtual environment.

One can teach various useful skills and demonstrate societal values through games. Games involving strategy and simulation have the strength of creating opportunities for experimentation and cultivating a hands-on approach to learning. Games involve learning everyday skills through direct experience, free exploration, and repetition. Furthermore, games evolve language, computer, and media skills and can instruct students in historical facts and values. Modern games can also provide learners an experience in social interaction and alternative methods of learning. The virtual learning environment supports the compounding of knowledge from information collected from the environment and the exchange of relevant facts between fellow players.

Central to the experience is the player's immersion into the world of the game. In digital games, the act of moving through space is of great importance, perhaps as important as the plot of the game and social interaction with others during gameplay. Because of this, these games emphasize exploration and discovery, finding and utilizing various objects and bits of information. It is important that the player feels at home in this virtual space as the experience as a whole is composed to a large extent of the interaction between the player and his or her environment. The game environment acts as a micromedium that amplifies interaction, motivates the player to solve problems presented by the environment, and encourages the player to learn and continue learning.

There is usually an idea of a fictional world behind games, a world where the player can act free from the restrictions of the actual world. Gaming is a multidimensional activity and it is largely dictated by the prerequisites of both game and player. The world that is opened up through games enables the player to perform feats that are simply impossible to execute in the real world. Succeeding in these virtual tasks strengthens the player’s ego and self-esteem. Games are played for the pleasure they produce and the experiences they offer. As the objectives posed by the game are achieved, the goal of educational gaming, microlearning, takes place.

The virtual game and learning environment gives the concept of microlearning a new form and supplies it with fitting content. This tool enables the simulation of real-life situations which can then be tackled inside the safety of virtual reality. The environment integrates familiar Internet applications and working methods, and it enables players to browse through microcontent and accumulate useful information, microknowledge. Traveling through the environment can itself be considered a learning experience. Furthermore, the flexibility of the digital information supplied by the environment enables it to be exported into other applications and platforms, such as mobile devices, in the future. Virtual learning environments demand a fresh conception of information and teaching, but they also supply new possibilities for uniting learning in the real world and learning that occurs with the aid of computer networks.

Games present a difficult situation for teachers and parents. Due to the fast pace of modern culture, teachers and parents find it difficult to keep up with progress. With games, problems such as commercialism and excessive consumption present conflicting scenarios. Games and computer networks can become a problem if they displace social interaction in the real world. Excess violence in games is often, and rightly so, emphasized in the media as well.

Teachers and schools can no longer view themselves simply as distributors of information. The focus of education is shifting towards the task of understanding a computerized digital world that contains great amounts of noisy information. The functions of games and learning environments are converging and more often than not learning in this setting occurs in a less self-conscious manner using modern digital instruments to explore and test the large quantities of information that is available to young students. Active learning such as this produces a learning experience that the student will remember for a very long time. Learning, in this sense, consists to a large extent of adapting and processing information to suit a great variety of different

contexts. Experience has shown that young students are drawn to game-like learning environments and find in them the necessary motivation to undertake the study of a given subject. Retrieving strategically placed bits of information produces a clear picture of the subject as a whole, provides an enjoyable gaming experience, and, most importantly, inspires learning.

References

Ermi, L., Heliö, S. Mäyrä, F. 2004. Pelien voima ja pelaamisen hallinta. Hypermedialaboratory net series 6. University of Tampere.

E-learning Nordic 2006. Impact of ICT on education. (http://www.edu.fi/julkaisut/eLearning_Nordic_English.pdf)

Gee, James Paul (2003) What Video Games Have to Teach Us About Learning and Literacy. Palgrave Macmillan, pp. 240

Hämäläinen, R., Manninen T., Järvelä, S. & Häkkinen, P. (2006) Learning to Collaborate - Scripting Collaboration in a 3-D Game Environment. International Journal of Internet and Higher Education (INTHIG), Vol. 9, Issue 1, Elsevier, p. 47-61,

Lim, CP, Nonis, D., & Hedberg, J. (2006). Gaming in a 3D multi-user virtual environment (MUVE): Engaging students in Science lessons. British Journal of Educational Technology 37 (2), 211-231.

Manninen T. & Korva T. (2005) Designing Puzzles for Collaborative Gaming Experience – CASE: eScape. In Selected Papers Proceedings of Digital Games Research Association's Second International Conference. de Castell S. & Jenson J. (eds.), June 16-20 Vancouver, Canada, pp. 233-247.

Rieber, L. (1996). Seriously considering play: Designing interactive learning environments based on blending of microworlds, simulations and games. Educational Technology Research and Development 44 (2), 43-58.

Salen, Katie & Zimmerman, Eric (2004) Rules of Play: Game Design Fundamentals. MIT Press, pp. 650

Students on the fly: Preliminary data from a year-long ethnographic study of students with a Mobile PC

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Abstract

As part of an ongoing, year-long ethnographic study on laptop adoption and usage, selected families, young professionals, and students in Tempe Arizona and the Puget Sound area in Washington State have been given some form of laptop computer, based on activity maps participants furnished to researchers. These 32 participants, 12 of them students, are being followed for one year as they report on their experiences. Preliminary data after one month reveal some surprises: A quarter of the students expressed desire/need for larger font sizes on their laptops; all students receiving a laptop without a CD/DVD drive complained that it depressed some of their mobile desires; and stylishness, even in a larger device, played a prominent role for some students. After initial excitement over Tablet functionality (rotating screen, pen), usage at this stage for the most part entails using the pen to navigate.

Unknowns about long-term laptop usage

Although we have conducted myriad lab studies on users' first experience with isolated features as well as employed benchmarking studies to assess users' ability to complete major tasks within an acceptable time, fewer longitudinal studies have been undertaken to learn what users' overall experience with their machine— in this case, a laptop— is like for customers over time. Outside of laboratory conditions, what actually happens once people get a new mobile PC? What are their pain points, areas of pleasure, and usage expectations? How successful is their laptop experience in meeting their expectations? Finally, how can we at Microsoft and our partners who manufacture laptops do a better job serving our customers?

Digital Lifestyle 20/20 Study

To address these questions, three user researchers in the Mobile and Tailored Platform Division at Microsoft have begun a year-long study, "Digital Lifestyle 20/20," following three groups: young professionals, families, and students. Our goals are to deeply understand consumers, provide our product teams with a clear view of the future landscape of mobile computing, create opportunities for direct customer connection, as well as serve as a research platform for our Mobile & Tailored Platforms division groups beyond our own. Of major interest in the student segment are questions surrounding the ways in which PC mobility— or its promise— affects students, both in terms of their learning and their lifestyle.

Who are the student participants?

The twelve students are all in college or graduate school and range in level from freshman through the third year in medical school. Students range in age between 19 and 32, with the oldest a returning student who is currently a sophomore. Effort was made to recruit couples of friends in order to study communication habits throughout the day. Thus, there are four "couples" and four participants who were not recruited in connection with a friend.

Research Design

Given the nature of what the team was seeking, namely to discover what customers' experience would be had *they* purchased the laptop, extreme care was taken to adhere to ethnographic principles of "pure" observation and yet an effort at empathic understanding at the beginning of the study(Schweizer,1998). Participants at this point still do not know why we are interested in them beyond learning that we are interested in the lifestyles of people like them in order to build better products. Thus, when several student participants asked "What do you want me to do?" they were asked to "Do what you would do if you had bought or were given the laptop. We are interested in what you would do on your own."

Once we have completed collecting data on discoverability and initial usage patterns, however, participants will be asked to perform special tasks by way of helping the product teams understand whether, then when and how customers would use a proposed feature. The plan is for the study to become increasingly "dirty" with these assignments to see which activities are adopted. Overall adoption patterns will also be determined.

The research design encompasses several stages: An interview with potential participants to gather data on their lifestyle and activities. From among this larger group of 30, a sub-set of 12 students was selected for the longitudinal study. We selected what we thought would be the most appropriate laptop to give that individual as a gift. We gave the laptop/Tablet to each participant at their dorm/apartment/or home, observing their out-of-box experience (OOBE); then over the succeeding month, general inquiries were made about how the participant was doing with the new laptop. Data collection methods included a special send-a-smile/send-a-frown application allowing participants to easily screenshots accompanies by comments at any time regarding their experience to a database.

Over succeeding months, increasing requests to fulfill "homework" assignments related to mobility. They will also be interviewed four more times, using methods of Spindler (2001). Whether participants adopt their machines or abandon them, they will be able to keep them for being so helpful. Moreover, the threat of having the laptops "confiscated" for non-use would seriously compromise the results.

Finally, at a later stage in the study, most participants will be given a second, ultra-mobile PC (7" screen or less) to see whether this form factor will drive behavior, and if so, how.

Limitations of the research design

After some debate it was decided that participants should not choose their devices. The concern was that they would choose more expensive equipment just because it was free and not because it would best fit their lifestyle. For the most part, the participants were very happy with the machines they received.

Another problem is that, with any gift, they may feel that they need to please the researchers by offering favorable feedback. Using the methods of They may want to please us by giving more favorable feedback.

Seeking out differing grade levels and economic circumstances, and deploying different machines are bound to produce different obstacles and pleasurable aspects to our users' experience, though we are finding commonalities even in these varying circumstances.

Finally, it is a subjective study. The findings indicate possible trends rather than final certainties.

Collection Methods

Our data-collection methods include several visits (at approximately 2 month intervals), activity maps drawn by participants, and in-home or in-dorm observation including shadowing for part of one day. Assignments include emails, blogs, diaries, and web surveys. Selected participants will also attend focus groups, with all participants

sending “send-a-smile/send-a-frown” feedback to the company database so that students have an easy way to make their opinions known when the situation is occurring. The aggregate data will offer a view of long-term trends across participants.

Machines deployed to students

Our twelve students received various types and makes of laptop, over half receiving Tablets:

3 - Toshiba M200 Tablet PC (12” display; 4.6 lb.)
2 - Lenovo x41 Tablet PC (12.1” display; 3.5 lb.)
2 - HP (Compaq) TC4200 Tablet (12.1” display; 4.6 lb.)*
2 - Acer Ferrari (15.4” display; 6.4lb.)*
3 - Sony Vaio
    1 - Vaio S380B (13.3 “ screen 4.2 lb. 1280/800 resolution)
    2- Sony Vaio SZ240 (13.3” 4.07 lb)

Recently the distribution has changed to one student with HP TC4200 and three with the Acer Ferrari due to one student needing a larger screen due to eye strain and lack of CD/DVD drive in the HP Tablet.

Toshiba M200 Tablet

Preliminary findings about students

At this point, all 12 students are still using their new laptop as their primary computer. Size and weight do appear to be *one* driver of mobility, as would be expected:

“I've been taking my laptop to school every day so far and it's great! It's so light and I bought a sleeve for it so I just carry it in my backpack without it getting scratched! I love how portable it is.” Vy

Surprising problems and misconceptions

Perhaps the biggest surprise to date has been font size. Four out of twelve students reported a strong desire for larger fonts. In fact, one recipient of a Tablet, a petite Junior who lived some distance from the university, opted to exchange it for a much heavier machine with a 17” screen:

“I don’t like hand-held PCs because my eyes aren’t that good; they make my head hurt….. I go to 150% and zoom on graphics……. I’d like a large screen.” Kaimi

Another student spent a lot of time finding a way to enlarge the fonts in Windows.

“The font onscreen is pretty small [on her new Toshiba M200]. You have to squint to read it.” Danielle

The other two students also spontaneously expressed a desire for larger screens for viewing as well as for handling windows:

“[Ideal is] a 17” screen-- It’s just easier to see, not that I have bad eyesight. But sometimes I like to have multiple windows, my desktop icons.” Yvonne

“I bought a small screen [computer a few years ago] and when there are multiple windows open it is hard.” Maegan

Another surprise for the team was the degree of frustration that 6/7 of the students experienced because their machines were not equipped with a CD/DVD drive.

“I feel that it is very odd that such a fancy computer doesn’t have a place for CDs and for that I am ☹.” Tracy

“This is one of those things that you never realized how much you use it until you don't have it. … I'm able to look up the downloadable

software for things like my printer, but I can't do things like listening to CDs on my new laptop." Erin
Another student complained:

Really bummed that this does not come w/ a CD ROM. I would love to install some of the programs I have (Quicken, my wireless keyboard drivers, screensavers, etc) but cannot do so because they are on disc. Yvonne

One interesting facet is that the students didn't associate greater weight with the inclusion of a CD/DVD drive. When this was pointed out, they all saw that it seemed reasonable in retrospect but it would not have occurred to them on their own.

Hardware pleasures

The superb style of the Ferrari and Vaio machines at first appeared to drive portability for four of the participants. This result occurred even when the laptop was heavy- the Ferrari weighs just over 6 lb!(2)

Hardware problems

A lot of surprising data about users' confusion over the machines emerged during the OOBE. This data will be transmitted to the relevant laptop manufacturers. Many of the participants, even those who had had laptops, still fumbled with the two laptop cords, which connected to each other and then to the laptop. Another area of confusion was finding the Tablet pen.

Noise was also mentioned by three of the participants. One Vaio owner noted:

"Fan on the right side of laptop is kind of loud. It goes on and off every couple seconds and is a little distracting, especially in a quiet area such as a library. " Vy

Two of the Ferrari owners grew jaded about the roaring engine sound at start-up, and one finally disabled it.

Clearly noise problems would dampen a number of mobility scenarios, including that of the library.

Software problems

On first launch of the Tablet, a large soft keyboard appears. This was confusing to all who received a Tablet, and did not help any of the participants. One participant was totally stymied and finally had to be helped to dismiss it because it does not have any "close" or "minimize" controls and can only be moved by the pen, not the mouse.

Expected problems

Battery complaints
Even though the machines were a lot newer than participants had owned, they still found battery life of 3 or fewer hours challenging:

"The battery seems to run down a lot more often than the other computer did. " Kaimi, who found the Ferrari battery to last less long than the HP 4200 Tablet she had previously been given.

"Worst battery life ever." Destiny

No ubiquitous wireless in Tempe
Getting a new machine connected wirelessly is challenging under most circumstances, but the promise was that Tempe would be different. We were therefore surprised to find it was also challenging in Tempe as well. This has compromised our efforts to compare a wireless city to an area that is not wireless.

Tablet PC owners showed initial enthusiasm

Students were intrigued and excited as they opened the boxes and found Tablets (all participants had read a description of the machine they were to receive before opening the box):

"Oooooh! This is nice. This is nice for notes….. See? I didn't know when a swivel screen is handy and now you can see why." Danielle:

"I love how the software translates my handwriting into text!!" Alberto

Maegan appeared less enthusiastic during the deployment visit but intrigued enough to take the tutorial during the first week:

"I just did the exercise for getting to know your tablet pc (i.e., how to use the pen) and it was excellent-clear and a manageable "first bite".

"Oh, it'll be fun to try out the stylus… that's nice, cool!... Will the screen swivel so that it becomes flat? Awesome!" Yvonne

The following dialogue occurred between Erin and Tracy, each of whom got a Lenovo X41 Tablet:

Tracy: "I want to see if it turns!
Erin: "It does, goof-ball…. Pretty awesome."
Tracy: "Yeah… Wow, I've never seen anyone use one of those…"
Erin: "This is going to be fun. Wow…"
Tracy: "It's high-tech."
Erin: "Oooh, I'm in heaven already, see what this weighs! From my [old] laptop you can't believe what a change this is."

Tablet usage over time did not match initial enthusiasm

Over the past month, some Tablet usage Remains. Four out of seven Tablet users have used their pen to handwrite or draw, and five of seven used the pen to navigate, if occasionally. It is unclear how many students are using applications supporting Tablet or what those applications are. In any case, there do not appear to be any obvious difference in mobility between the Tablet and laptop owners.

Next Steps

At the end of October 2006, those without CD/DVD drives will receive them, and we will learn whether having them (at least small, external drives) will produce more mobile behaviors. In November, students will receive their first overt mobile assignments, e.g., to perform a task in a place outside of their normal routine. During our December visit, participants will be shadowed for a few hours in order to fill in some of the blanks about their actual behavior (e.g., what apps they are actually using). Early next year their machines will be upgraded to Vista to learn what effect that may have on their behavior. Decisions are still being made whether to deploy UMPCs (Ultra-Mobile PC) to all or to selected participants. It is still too early to derive assumptive personas (Pruitt and Adlin, 2005), as had been hoped, but themes are emerging and we hope to have several personas emerging by the end of the study in the summer of 2007, along with a much enlarged picture of mobile behaviors and promise.

References

Pruitt, John, and Adlin, Tamara, *The Persona Lifecycle: Keeping People in Mind throughout Product Design*. San Francisco: Morgan Kauffman Publishers, 2005.

Spradley, James. *The Ethnographic Interview* . Belmont, California: Wadsworth Thomson Learning, 1979.

Spindler, George, ed. *Fifty Years of Anthropology and Education 1950-2000*: A Spindler Anthology. New Jersey: Lawrence Erlbaum Associates, 2001.

Reflections on Success: A retrospective of the mLearn conference series 2002-2005

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Abstract

mLearn is now in its fifth year. Although mobile learning has a much longer history, the inauguration of a conference for learning in the mobile age marked an important point in its development. This paper takes a retrospective look at the mLearn conferences from 2002 through to 2005; reflecting on our progress in order to facilitate the transition of mobile learning from a novel research concept into a viable means of providing meaningful learning opportunities "across generations and cultures". We hope that this paper will act as a mini-compendium or ready-reference for those embarking on mobile learning projects, a starting point for those entering the field and a reminder to those who have already contributed to its making.

Introduction

Background to mLearn

Mobile learning as a concept has a long history. Alan Kay originally proposed the Dynabook system in the early 1970s. Building on educational theories of Piaget and Papert, the Dynabook was intended to be a personal, portable device through which children of all ages could express themselves (Kay, 1972). It is only in recent years, however, that mobile technology, in the form of mobile phones, handheld computers and high speed wide area communications, can truly enable learning on the move. HandLeR, originally proposed as a student project, was the first technological embodiment of a personal, mobile system to support lifelong learning (Sharples, 2000; Sharples, Corlett & Holme, 2002). This project went on to receive funding from British Telecom and Kodak and sparked the development of an active mobile learning community at the University of Birmingham in the UK.

At the same time, mobile learning was beginning to be recognised as a legitimate research field in its own right. The European Commission, through the Information Society Technologies' (IST) programme, put their support behind two large mobile learning projects – m-learning (www.m-learning.org) and MOBIlearn (www.mobilearn.org). The m-learning project, launched in October 2001, had participating institutions in the UK, Sweden and Italy. It was aimed at young adults, aged 16-24, who had left formal education and thus were at risk of social exclusion in Europe. The objectives of the project were to develop prototype products and services that would deliver information and learning experiences through a variety of mobile technologies. The MOBIlearn project, launched in July 2002, involved a consortium of 24 academic and industrial partners from Europe, Israel, the USA and Australia. Its aim was to

explore context-sensitive approaches to mobile learning for informal, problem-based and workplace learning.

In June 2002, the University of Birmingham hosted the first mLearn workshop (www.eee.bham.ac.uk/mlearn/). Termed the 'European Workshop on Mobile and Contextual Learning', it brought together researchers and practitioners from both industry and education. Whilst the 32 submissions indicated a range of research and development initiatives, the focus of the conference was mainly on UK-based projects.

Building a Community

The LSDA (LSDA), the coordinating partner of the m-learning project, organised and hosted mLearn 2003 (www.feda.ac.uk/events/mlearn2003/) in London, UK. The theme of this conference was "learning with mobile devices" and though the audience had expanded significantly as compared to the previous year, the submissions were still predominantly UK-based. mLearn 2004 (www.mobilearn.org/mlearn2004/) moved outside of the UK for the first time to Bracciano, Rome and was organised by the MOBIlearn project. The theme of this conference was "learning anytime, everywhere" and the number of papers submitted was more than double that of the previous year (56 compared to 27). The international nature of the mobile learning community was also beginning to emerge – submissions were received from 16 different countries, including Romania, Canada, the USA and South Africa.

Though the m-learning and MOBIlearn projects had officially concluded by 2005, by this time a substantial and diverse mobile learning community had been consolidated. When mLearn 2005 (www.mlearn.org.za) was hosted in Cape Town, it was the key research and networking event for researchers, strategists, educators, technologists and practitioners from around the

world. The theme of the conference was "Mobile technology: The future of learning in your hands", and submissions were received from 18 different countries, including for the first time Brazil, Colombia, Guatemala, Israel, Cyprus and the Netherlands. Importantly, 15 of the 59 submissions highlighted the important role that mobile learning was playing in Africa.

The true success of the mobile learning community can be seen in the number of events and conferences specifically focused around mobile learning. These include international conferences such as the IEEE's annual conference on Wireless and Mobile Technologies in Education (WMTE) and the annual IADIS Mobile Learning Conference, as well as several regional events. In Europe, the Kaleidoscope Network of Excellence is sponsoring a Mobile Learning Initiative (http://www.noe-kaleidoscope.org/group/mlearning/) and in the United States, EDUCAUSE is focused on exploring Mobility and Mobile Learning through a dedicated Learning Initiative (http://www.educause.edu/MobileLearning/5527).

Structure of this Paper

In this paper, we identify successful projects from the mLearn community and examine their positive outcomes. Next, we describe patterns we have identified, based on the common features shared by these projects, and corroborated by published results from the mLearn proceedings. These are then abstracted and distilled into set of critical success factors (CSFs) that can be used to inform both future developments and policy initiatives. Finally, we discuss the current challenges facing educators and technology developers in incorporating mobile learning into mainstream educational provision.

Positive Outcomes of Successful Projects

In this section, we highlight six outcomes of successful projects from the mLearn community. Examples are drawn from a number of countries and learner profiles to demonstrate how mobile learning is truly reaching 'across generations and cultures'.

Motivation

There is evidence from across the mLearn community to suggest that mobile learning has a significant impact on learner motivation. According to Butler (2002), "site-wide wireless coverage has transformed" (p. 57) the teaching and learning at Djanogly City Technology College in Nottingham, UK. Students who previously found paper-based assessments to be tedious and nerve-wracking are now requesting extra time over breaks and lunchtimes to complete their assessments online. When mobile computing devices were introduced into classrooms in Ohio, USA, both students and teachers observed an increase in motivation, leading to increases in both the quantity and quality of student work (Swan, van `t Hooft, Kratkoski & Unger, 2005).

Mobile learning also enhances motivation outside the classroom. At the Tshwane University in Pretoria, de Crom and de Jager (2005) used PDAs during ecotourism field trips as an alternative to paper-based worksheets. They found that the use of the PDAs enhanced motivation by stimulating fun, curiosity, challenge, satisfaction and interest among their learners. In Oulu, Finland, Mattila and Fordell (2005) developed MOOP, an interactive mobile learning environment for primary school pupils. Learners use a variety of mobile phone features (camera, text messaging, GPS location tracking) to support them in cooperative, inquiry-led learning situations. Over 1000 pupils have used the system and have enjoyed both the opportunity to learn

by being immersed in their environment and the opportunity to learn how to use the various features of the mobile phones. In the students' own words, mobile learning is 'cool'.

Engagement

Closely related to motivation, mobile learning seems to promote high engagement in various learning activities. In Ohio, Swan et al. (2005) notes that students were particularly engaged when using mobile devices to record data from a variety of experiments. They propose that the portability and data storage capacity of the devices may have helped to alleviate the drudgery of working with data. A more exciting prospect noted by one of the students is that "mobile computing makes such activities seem more like what '*real scientists do*'" (p. 160). The EngageMe project from TAFE New South Wales, a member of the Australian Mobile Learning Network, engages young people in e-learning by providing opportunities for them to generate content and responses (Ragus et al., 2005). Camera and text features of the mobile phone are used, as these are technologies that the learner group readily embraces in their daily lives.

The portable nature of mobile devices also allows learners to engage with their environment. Naismith, Sharples and Ting (2005) evaluated the use of the CAERUS system to deliver location-based multimedia content to visitors in a botanic garden in Birmingham, UK. The participants in their trial showed increased engagement with their physical surroundings, as evidenced by being able to cite specific examples of things they had seen or heard, increased knowledge of the layout and organisation of the garden and a strong desire to explore further and receive more information. Bradley, Haynes and Boyle (2005) also use multimedia to engage users and "bring history alive" (p. 23) on a mobile local history tour in London, UK. All 10 of

their trial participants found the tour to be memorable and 9 of them reported it to be both stimulating and enjoyable.

Personalisation

Personalisation is about giving learners control over what, where, when and how they will learn. The effectiveness of mobile devices as learning tools stems from the personal nature of the devices themselves (Cereijo Roibás & Arnedillo Sánchez, 2002). By presenting information that is also perceived as personal, high levels of user attention can be captured.

There are several examples of mobile device applications designed around learner needs. The PDA-based Student Learning Organiser (Holme & Sharples, 2002; Sharples, Chan, Rudman & Bull, 2004) is designed around the needs of university students at the University of Birmingham, UK. It provides specialised support for time management and accessing course materials through the wireless network. Importantly, students on their trials were given full control over how they chose to use (or not use) the devices. Also from the University of Birmingham, the Interactive Logbook (Bull et al., 2005; Corlett, Chan, Ting, Sharples & Westmancott, 2005) is a personal learning environment (PLE) which helps users to plan, track, manage and review their learning activities. In contrast to institutionally provided learning environments, the Interactive Logbook allows uses to select a "personal suite of tools or resources according to individual learning styles and work habits" (Corlett et al., 2005, p. 32).

The design of learner-centred interfaces is not restricted to traditional educationally settings. Wood, Price, Laird and Robertshaw (2002) from Liverpool, UK developed a PDA-based breast cancer support tool that places the "patient as a central pivot to the content" (p. 31).

Based on a timeline metaphor, users can navigate backwards and forwards through time in relation to their current treatment, and select to receive further information where appropriate.

Collaboration

Colley and Stead (2005) have learned that while "users enjoy the content, they love the collaboration" (p. 57). They developed a tool called mediaBoard, which allows young adult learners from the mLearning project to contribute to shared websites using text and picture messaging. Learners use this technology as a facilitator for their creative ideas, thus supporting a community of practice approach.

O'Malley and Stanton (2002) evaluated the use of a variety of digital and physical technologies to support storytelling in small groups of 7 year-old children in Nottingham, UK. The tangible set-up included a 'magic carpet' to navigate through the story as well as barcodes and scanners for uploading pictures that the children draw onto a large screen. The children could also draw and input pictures using a PDA. The children were able to collaborate effectively and create physical and digital versions of stories with both pictures and sounds. The large screen was particularly effective at making everyone's actions visible to the group, and the PDAs enabled the children to switch smoothly between individual, paired and whole group activities.

The success of collaborative mobile learning in practice has led to the development of a number of theoretical models. Barker, Krull and Mallinson (2005) propose a theoretical model for the adoption of mobile learning in developing countries. They state that handheld devices can facilitate successful collaboration by allowing "learner groups to distribute, aggregate, and share information with ease" (p. 18) and include collaboration as a critical success factor in their

model. In Chile, Zurita and Nussbaum (2002) have developed a mobile computer supported collaborative learning (MCSCL) model to address problems with coordination, communication, management and lack of mobility that are inherent in traditional collaborative learning activities. Learners can interact both socially and through their wirelessly-networked handheld devices. Applying this model to collaborative learning achieves "positive interdependence, individual responsibility, mobility, group processing and face-to-face communication" (p. 65).

Interactivity

SMS, or text messaging, is widely reported as an effective tool for promoting interactivity. Stone and Briggs (2002) invited a group of 1000 university students in the UK to take place in a prize draw, which was announced to them by either email or by SMS. Only 1.6% of the email group responded, while SMS response rates ranged from 17% to 25% (with most responses received within 30 minutes of the initial request), indicating a willingness amongst students to respond to an SMS request for interactivity. Stone and Briggs suggest that this indicates that "timely, relevant support services" (p. 12) would be welcome by university students. At the University of Cape Town in Ng'ambi (2005) used SMS to address educational challenges of under-prepared students, large class sizes and diversity and add value to student learning. Students can submit an anonymous question (dynamic frequently asked question or DFAQ) by SMS, which is received by the tutor through a web interface. The response is sent back to the question author via SMS, but is also available as a resource for the whole class to view. The students can thus learn from exposure to other students' questions and the tutor receives important feedback on where students' difficulties lie.

Interactivity is also about providing opportunities for learners to respond to their environment and experiences. In a pilot of a multimedia tour at the Tate Modern in London, UK, many of the visitors' favourite stops on the tour feature a design approach involving interactive messages, "in which visitors had a chance to respond to artworks or register their opinions" (Proctor & Burton, 2004, p. 129).

Sense of Community

Mobile learning can be used to inspire the development of a community of practice approach to learning. Brandt, Hillgren and Björgvinsson (2004) describe a project at an Intensive Care Unit in Sweden in which self-produced videos are shared peer-to-peer by staff members and viewed on mobile devices. The staff members are given the responsibility for setting the content and deciding how to produce the videos. A direct impact on the success of the project has been that "the person on the video and the colleagues watching it all share the same social and cultural community of practice" (p. 27). The collaborative nature of the production process helps to make their work practices visible for more colleagues, thus enhancing opportunities for reflection and professional development.

Mobile learning can also help learners to feel a sense of belonging to the wider community. Leach, Power, Thomas, Fadani and Mbebe (2005) describe a project in which handheld computers were used to promote professional development amongst teachers in rural African settings. One of the important outcomes of this project is that it has raised the teacher's perception of their own professionalism and raised the esteem of teaching in the eyes of the community. Facer, Faux and McFarlane (2005) describe a project called The Handhelds Initiative in the UK that aimed to increase community engagement and motivation for learning.

The results of this project indicate that the handheld devices extended community access to ICT. School children taught their parents how to use the devices, which led to increased engagement with formal education by both the students and their families.

Critical Success Factors

There are many features of a project that can 'make or break' it. However, there are five that recur so frequently within the mLearn literature, that they are worthy of particular note. We have termed these features Critical Success Factors, or CSFs.

Availability of Technology

Whether provided *for*, or *by* the learner, successful mobile learning projects make mobile technology available. There are more projects to date that have relied on the provision of technology to learners, rather than employing learners' own equipment. There are many reasons for this including the need for equity, the desirability of a common platform, and the availability or otherwise of technology among the participant population.

The University of Cape Town has successfully used learners' devices, harnessing the ubiquity and simplicity of SMS text messaging on a mobile phone (Ng'ambi, 2005). In a situation where PCs were generally not found in students' homes, nor were campus clusters available 24 hours a day, 7 days a week, this ready source of hardware was very valuable. Furthermore, the students were already "communicatively competent with SMS" (p. 116), which reduced the need for training and support. Other projects have leveraged funding from specific initiatives (Butler, 2002), from government (Facer et al., 2005), investment from hardware manufacturers (Corlett et al., 2005; Cacace, Cinque, Crudele, Iannello & Venditti., 2005) or from

research programmes (Colley & Stead, 2005). Interestingly, there was rarely a long-term strategy for sustained use of technology beyond the funding horizon.

Institutional Support

Whilst one of the major benefits of mobile learning is the ability to put control in the hands of the learner, it is observed that successful projects have good institutional support. Aspects that may be seen as peripheral to a project often have significant impact. Extensive and well thought out support resources, including staff training and equipment/software maintenance are essential.

Burke, Colter, Little and Riehl (2005) cite staff training as "the most crucial element affecting success of such a project" (p. 31). Their ongoing wireless and mobile development at the University of Tennessee has seen the ubiquitous wireless coverage of the campus, extensive training of staff and technical training and support for all the students who take part in mobile-enabled classes. Use of mobile technology was not imposed on the staff, but rather provided in response to staff who worked collaboratively to develop and refine wireless teaching strategies and activities. Delivery was integrated with the institutional Virtual Learning Environment (VLE).

At Sussex University, the institutional commitment was evident in covering the costs of connectivity via a mobile operator (Luckin, Brewster, Pearce, Siddons-Corby & du Boulay, 2004). Meanwhile, the m-learning project (Attewell & Webster, 2005) saw the collective resolve of 14 organisations result in 300 disadvantaged learners receiving the opportunity to engage in a new way.

Butler (2002) demonstrated how it was necessary to see mobile learning as part of the bigger picture, not only in terms of ICT provision, but also in thinking of the user's perspectives as learning individuals, teams, organisations and communities.

Connectivity

Successful mobile learning projects incorporate wireless network access, whether through local wireless LAN, or over the mobile telephone networks. A lack of connectivity can cause significant disruption to many mobile activities (Sharples et al., 2004).

In a project to support trainee teachers with handheld computers (Wishart, McFarlane & Ramsden, 2005), access to the internet was considered to be the most valuable use of the devices for both teaching and the trainees' own learning. The ability to answer "virtually any question" (p. 186), using the device as a "distributed memory system" (p. 186) was paramount. The speed of the connection seemed less important than the ability to connect anytime and in any place. The trainee teachers found GPRS, though much slower than broadband, to be acceptable for their purposes.

At Djanogly College (Butler, 2002) as elsewhere, wireless mobile computers were used to solve the problems of space and scheduling. Here, increased access to ICT was not feasible with traditional fixed desktop solutions. Breaking with the paradigm of the 'computer room', technology became a tool to support the learning rather than an end in itself, with improvements in learner motivation and achievement being recorded.

Connectivity can be closely monitored, which makes it a useful metric for evaluating the technology. At Sussex University (Luckin et al., 2004), students were provided with mobile

devices capable of voice calling, SMS, email and internet access. Logs of data usage and messaging between students could be tracked to discover patterns of use and of collaboration.

Integration

Successful mobile learning projects do not stand apart, but are integrated with the curriculum, the student experience or 'real life', or indeed any combination of the three.

One reason for integrating closely with the curriculum is the increased engagement of teaching staff who may not be natural innovators. A clear link must be provided between what they are expected to teach and the materials and tools they use for teaching it. Facer et al. (2005) noted a risk that schools would use handhelds not because they met a specific learning need, but simply because they had them. They also pointed to significant attrition in usage as the novelty wore off. Specific ties to the curriculum would perhaps have helped to reverse this decay of interest. In higher education, it can be helpful to use mobile devices in conjunction with professionally relevant technologies, such as temperature probes for Food Technology, GPS for Environmental Science and digital cameras for Plant Pathology (Burke et al., 2005).

One way to achieve good integration with the student experience is to start with something that already exists in the learning process and use the mobile device to make the activity easier, more engaging or of greater value. At the University of Cape Town (Ng'ambi, 2005), this was achieved by taking an online FAQ system already in use, and adding the ability to interact with it anonymously using SMS. This brought greater utility and speed with anecdotal evidence of improving learning and reflection.

The Interactive Logbook Project (Corlett et al. 2005) sought to place a piece of mobile software at the centre of the student experience. Curriculum-independent, it provided a suite of

tools to support the common everyday tasks of the learner. It was then left to the learners themselves to integrate it with their own working patterns and learning styles.

The m-Learning project set out to deliver learning that was "contextualised and blended into existing, real-life learning experiences" (Collett & Stead, 2002). This was important to the design such that the learners did not see themselves as "simply 'guinea pigs'" (Attewell & Webster, 2005, p. 17). Because mobile learning met or exceeded expectations, it became a route to further learning with and about IT for many participants, rather than the disappointment or turn-off that other projects have discovered.

Ownership

Ownership of technology helps to promote ownership over learning. It is important that learners either own the technology or at least treat it *as if* they own it. This means the ability to use it any time they wish, to be free to customise or upgrade it, or even to use it subversively.

As Attewell and Webster (2005) discovered, ownership can bring with it motivational benefits – some of their learners were surprised and proud to be trusted with expensive and sophisticated technology. This in turn led to very low loss or damage rates.

Luckin et al. (2004) compared usage where one cohort of students was provided with one device each, while another cohort was required to share one between three or four. Those sharing were perceived to be at a severe disadvantage for personal communication. Facer et al. (2005) noted that where the handhelds were given to new groups of school pupils each week, limited options existed for personalisation of the devices. Conversely in the same study, even where teachers stopped using the devices to support curriculum, some pupils continued to use them for personal activities including personal organisation and diarising.

Given the opportunity, students will use mobile devices for entertainment and socialising as well as for educational purposes (Corlett & Sharples, 2005) – even watching movies or messaging friends during formal lessons. However, where this occurs, the student is likely to make more use of the device for learning purposes than they would otherwise. The same study also noted that technologies compete for the user's attention. Students with their own mobile devices were less likely to use loan equipment, even if it was considerably more sophisticated, since they had already invested money and time in acquiring and personalising their own.

It may be necessary to allow usage of the technology beyond a given trial in order to guarantee participants' loyalty to the project and the technology. Burke et al. (2005) pointed out the dangers of making a portable computer central to a student's learning style, only to take it away again before the course or programme is completed.

Challenges for Educators and Technology Developers

The mLearn literature is rich with complaints about the challenges facing mobile learning. Along the way, however, we have discovered some helpful pointers, with a few recommendations for future work common to many projects. We have tried to remain solution focused and consequently have picked out papers that help to shape thinking towards overcoming these challenges.

Improving Technical Reliability

There are many documented problems with the reliability of mobile devices, in particular handhelds. These include battery life, network connectivity, data loss and compatibility. Nearly all empirical trials have concluded with recommendations being made for improved

dependability. Facer et al. (2005) are among those who noted the waning of engagement by pupils as devices began to malfunction throughout a project.

Some projects developed strategies for overcoming difficulties with, for example, data loss, whilst other researchers would endorse the need to thoroughly test before use. Burke et al. (2005) found that even basic technologies such as SD or USB flash drives did not have universal compatibility, meaning that activities had to be restructured at the last minute to accommodate this.

There would seem to be a pattern that projects using simple and user-owned technologies have the fewest problems with reliability (see, for example Ng'ambi, 2005).

Building Teacher Confidence

Reflecting on their projects, many authors recognise lack of teacher training and experience as a factor in poor execution. Confidence, not only in the technical aspects, but also the educational value of handhelds is necessary, but sometimes lacking. To make good use of mobiles in the classroom requires a confident teacher. Teachers who lacked confidence with the technology were unlikely to use it in front of pupils (Wishart et al., 2005). Teachers may begin with an assumed confidence in the pupils' or students' abilities, but often this is unfounded (Burke et al., 2005). Self-declared competencies either do not match reality or cannot necessarily transfer to novel applications.

Interestingly, the m-learning trials discovered that there was no significant difference in outcomes whether tutors had extensive training and time to practice or not. In both cases, tutors expressed a sense of unpreparedness. However, it seems that the tutors' considerable commitment to the overall project may have transcended technical concerns.

Rethinking Mobile Learning Design

Learning design is important and in most cases a direct conversion of existing methods does not work. The mLearn literature is rich with suggestions of design principles, a few of them being:

- Create quick, simple interactions (Corlett et al., 2005; Luckin et al, 2004).
- Prepare materials that are flexible and can play to the heterogeneity of learners (Frohberg, 2005). Mobility means that the context of even one individual will keep changing, thus varying his or her needs (Morken & Divitini, 2005).
- Design access and interactions that account for the heterogeneity of devices and standards (Mattila & Fordell 2005), particularly taking account of presentation and input capabilities (Ally, Lin, McGreal & Woo, 2005; Graham, Bowerman & Bokma, 2004; Popat & Stead, 2005) .
- Consider a different approach to design, such as the use of non-functional requirements (NFRs) to match key user requirements to the capabilities of a device (Avellis, Scaramuzzi & Finkelstein, 2004).
- Consider special affordances (or even perceived limitations) of mobile devices that might add to the learner experience. Ng'ambi (2005) demonstrated this through using anonymity to empower questioning.
- Use mobile technology to not only 'deliver' learning, but also to facilitate it, since native applications (note-taking and time management for example) are well suited to this (Baber, Sharples, Vavoula & Glew, 2004; Corlett et al., 2005).

- When converting content from previous uses, take a staged approach to reviewing and repurposing it. (Rodin, 2005) This will identify problems early in the process.
- Apply Learner-Centred Design (Danielsson, Hedestig, Juslin, & Orre, 2004), since the teacher-centric model apparent in many learning environments is not appropriate.

Reducing Cost of Use

Not only the cost, but also the *perceived cost* of mobile learning must be reduced. Equipment and connectivity are only pieces of the cost equation, with development of tools, content and training playing a major part.

Connectivity costs using mobile networks can be high, but also not very transparent. Data is usually charged by the kilobyte, which is not easy for the user to translate into real activities (opening a web page, watching a video, sending an email). Tools to measure data usage are still poor and users are inclined to be overly cautious rather than risk a large bill (Luckin et al., 2004).

Keegan (2005) points to the revenue opportunities afforded by mobile learning. However, these are yet to materialise and the mobile operators are yet to see or understand viable business models linked to education. This is an important area for future development as mobile learning projects transition into mainstream education.

Future-Proofing

Mobile technology is a commodity product, presenting a significant challenge for learning designers. Knowing what will be fashionable, reliable, usable and available even in the coming year is at best guess-work.

To make the guesses more reliable, it is worth doing research to chart out a 'road map'. Attewell and Webster (2005) used this approach in the m-learning project to anticipate changing factors over the life of the project. These included delivery options, platform, media options, development languages and transport options.

Content can be created that is independent of the delivery mechanism. Arias, Reichenbach and Pasch (2005) describe a mark-up language used to package video with other materials and be delivered in the best possible way for a given target device.

One way to anticipate where technology will be going is to pay attention to international standards. Standards already apply to many aspects of eLearning, though there are none specifically governing mobile learning. Veith and Pawlowski (2005) have looked at how these standards can be tailored appropriately and have outlined the benefits to learners and authors by adopting them. Of course vendors do not always (or even mostly) adopt standards, unless there are market forces demanding them.

Summary and Conclusions

We hope this paper is an encouragement to those engaged in mobile learning development and a primer to those planning to embark on it. We also hope it will act to draw a line under what has been discovered to date and raise the bar for future projects.

First, we drew together the positive outcomes of successive projects and by triangulating the findings demonstrated that there are specific and verifiable benefits to mobile learning. Second, we showed that these outcomes are not automatic; to ensure even some of them requires paying careful attention to the features of what made the projects successful – the CSFs. Third, we recognised that there are still challenges that we as a community are beginning to understand,

but do not necessarily have solutions to yet. By considering these challenges, practitioners will reduce risk and by embracing them, educationalists and technology developers can add value to the growing body of research.

The principles that have been revealed and confirmed over many projects should, if adopted, serve to ensure a new minimum standard in undertakings while limiting the extent of unnecessary reinvention.

References

Ally, M., Lin, F., McGreal, R. & Woo, B. (2005). An Intelligent Agent for Adapting and Delivering Electronic Course Materials to Mobile Learners. *Mobile Technology: The future of learning in your hands,* Cape Town, 1-5.

Arias, R., Reichenbach, M. & Pasch, G. (2005). XML saves the day: Porting a Rich-Media Collection to a Mobile Platform in Three Weeks Flat. *Mobile Technology: The future of learning in your hands,* Cape Town, 8-13.

Attewell, J. & Webster, T. (2005). Engaging and Supporting Mobile Learners. *Mobile learning anytime everywhere: A book of papers from mLearn 2004*. London: LSDA, 15-19.

Avellis, G., Scaramuzzi, A. & Finkelstein, A. (2004). Evaluating non-functional requirements in mobile learning contents and multimedia educational software. *learning with mobile devices: research and development*. London: LSDA, 13-20.

Baber, C., Sharples, M., Vavoula, G. & Glew, P. (2004). A 'learning space' model to examine the suitability of different technologies for mobile learning. *learning with mobile devices: research and development*. London: LSDA, 21-25.

Barker, A., Krull, G. & Mallinson, B. (2005). A Proposed Theoretical Model for mLearning Adoption in Developing Countries. *Mobile Technology: The future of learning in your hands,* Cape Town, 17-22.

Bradley, C., Haynes, R. & Boyle, T. (2005). Adult Multimedia Learning with PDAs - The User Experience. *Mobile Technology: The future of learning in your hands,* Cape Town, South Africa, 23-27.

Brandt, E., Hillgren, P-A., Björgvinsson, E. B. (2004). Self-produced video to augment peer-to-peer learning. *learning with mobile devices: research and development*. London: LSDA, 27-34.

Bull, S., Bridgefoot, L., Corlett, D., Kiddie, P., Marianczak, T., Mistry, C. et al. (2005). Interactive Logbook: the development of an application to enhance and facilitate collaborative working within groups in higher education. *Mobile learning anytime everywhere: A book of papers from mLearn 2004*. London: LSDA, 39-42.

Burke, M., Colter, S., Little, J. & Riehl, J. (2005). Utilizing Wireless Pocket-PCs to Promote Collaboration in Field-based Courses. *Mobile Technology: The future of learning in your hands,* Cape Town, South Africa, 28-31.

Butler, M. (2002). Wireless Networks Case Study: Djanogly City Technology College Nottingham. *Proceedings of the European Workshop on Mobile and Contextual Learning*, Birmingham, UK, 57-60.

Cacace, F., Cinque, M., Crudele, M., Iannello, G. & Venditti, M. (2005). The impact of innovation in medical and nursing training: a Hospital Information System for Students (HISS) accessible through mobile devices. *Mobile learning anytime everywhere: A book of papers from mLearn 2004*. London: LSDA, 47-52.

Cereijo Roibás, A. & Arnedillo Sánchez, I. (2002). Pathway to m-learning. *Proceedings of the European Workshop on Mobile and Contextual Learning*, Birmingham, UK, 53-56.

Colley, J. & Stead, G. (2005). Mobile learning = collaboration. *Mobile learning anytime everywhere: A book of papers from mLearn 2004*. London: LSDA, 57-58.

Collett, M. & Stead, G. (2002). Meeting the Challenge: Producing M-Learning Materials for Young Adults with Numeracy and Literacy Needs. *Proceedings of the European Workshop on Mobile and Contextual Learning*, Birmingham, UK, 61-62.

Corlett, D. & Sharples, M. (2005). Tablet technology for informal collaboration in higher education. *Mobile learning anytime everywhere: A book of papers from mLearn 2004*. London: LSDA, 59-61.

Corlett, D. Chan, T. Ting, J. & Sharples, M. (2005). Interactive Logbook: a Mobile Portfolio and Personal Development Planning Tool. *Mobile Technology: The future of learning in your hands,* Cape Town, South Africa, 32-36.

Danielsson, K., Hedestig, U., Juslin, M. & Orre, C. J. (2004). Participatory design in the development of mobile learning environments. *learning with mobile devices: research and development*. London: LSDA, 47-53.

de Crom, N. & de Jager, A. (2005). The 'ME'-Learning Experience: PDA Technology and eLearning in Ecotourism at TUT. *Mobile Technology: The future of learning in your hands,* Cape Town, South Africa, 37-44.

Facer, K., Faux, F. & McFarlane, A. (2005). Challenges and Opportunities: Making Mobile Learning a Reality in Schools. *Mobile Technology: The future of learning in your hands,* Cape Town, South Africa, 53-56.

Frohberg, D. (2005). Mobile learning in tomorrow's education for MBA students. *Mobile learning anytime everywhere: A book of papers from mLearn 2004*. London: LSDA, 81-84.

Graham, P., Bowerman, C. & Bokma, A. (2004). Adaptive navigation for mobile devices. *learning with mobile devices: research and development*. London: LSDA, 61-67.

Holme, O. & Sharples, M. (2002). Implementing a Student Learning Organiser on the Pocket PC Platform. *Proceedings of the European Workshop on Mobile and Contextual Learning*, Birmingham, UK, 40 – 43.

Kay, A.C. (1972). A personal computer for children of all ages. *Proceedings of the ACM National Conference*, Boston.

Keegan, D. (2005). The incorporation of mobile learning into mainstream education and training. *Mobile Technology: The future of learning in your hands,* Cape Town, 65-70.

Leach, J., Power, T., Thomas, R., Fadani, X. & Mbebe, A. (2005). 4D Technologies: Appropriating Handheld Computers to Serve the Needs of Teachers and Learners in Rural African Settings. *Mobile Technology: The future of learning in your hands,* Cape Town, 95-102.

Luckin, R., Brewster, D., Pearce, D., Siddons-Corby, R. & du Boulay, B. (2004). SMILE: the creation of space for interaction through blended digital technology. *learning with mobile devices: research and development*. London: LSDA, 87-93.

Mattila, P. & Fordell, T. (2005). MOOP - Using mLearning Environment in Primary Schools. *Mobile Technology: The future of learning in your hands,* Cape Town, 107-111.

Morken, E.M., & Diviniti, M. (2005). Blended mobile and ambient technologies to support mobility in practice based education: the case of teacher education. *Mobile Technology: The future of learning in your hands,* Cape Town, 45-49.

Naismith, L., Sharples, M. & Ting, J. (2005). Evaluation of CAERUS: a Context Aware Mobile Guide. *Mobile Technology: The future of learning in your hands,* 112-115.

Ng'ambi, D. (2005). Mobile Dynamic Frequently Asked Questions (m-DFAQ) for Student and Learning Support. *Mobile Technology: The future of learning in your hands,* Cape Town, 116-119.

O'Malley, C. & Stanton, D. (2002). Tangible Technologies for Collaborative Storytelling. *Proceedings of the European Workshop on Mobile and Contextual Learning*, Birmingham, UK, 3-6.

Popat, K. & Stead, G. (2005). m-learning via the web: the challenge of size. *Mobile learning anytime everywhere: A book of papers from mLearn 2004*. London: LSDA, 167-169.

Proctor, N. & Burton, J. (2004). Tate Modern Multimedia Tour pilots 2002-2003. *learning with mobile devices: research and development*. London: LSDA, 127-130.

Ragus, M., Meredith, S., Dacey, D. Richter, C., Paterson, A. & Hayes, A. (2005). The Australian Mobile Learning Network: Australian Innovations. *Mobile Technology: The future of learning in your hands,* Cape Town, 130-137.

Rodin, L. (2005). E-learning to m-learning: an investigation into the potential for content conversion. *Mobile learning anytime everywhere: A book of papers from mLearn 2004*. London: LSDA, 171-175.

Sharples, M. (2000). The Design of Personal Mobile Technologies for Lifelong Learning. *Computers and Education*, *34*, 177-193.

Sharples, M., Corlett, D. & Westmancott, O. (2002). The Design and Implementation of a Mobile Learning Resource. *Personal and Ubiquitous Computing*, *6*, 220-234.

Sharples, M. Chan, T., Rudman, P. & Bull, S. (2004). Evaluation of a mobile learning organiser and concept-mapping tools." *learning with mobile devices: research and development*. London: LSDA, 139-144.

Stone, A. & Briggs, J. (2002). ITZ GD 2 TXT – How to Use SMS Effectively In M-Learning. *Proceedings of the European Workshop on Mobile and Contextual Learning*, Birmingham, UK, 11-14.

Swan, K., van't Hooft, M., Kratcoski, A. & Unger, D. (2005). Teaching and Learning with Mobile Computing Devices: Closing the Gap. *Mobile Technology: The future of learning in your hands,* Cape Town, 157-161.

Veith, P. & Pawlowski, J. (2005). Conception and Development of Reusable and Modular Mobile Content. *Mobile Technology: The future of learning in your hands,* Cape Town, South Africa, 171-175.

Wishart, J., McFarlane, A. & Ramsden, A. (2005). Using Personal Digital Assistants (PDAs) with Internet Access to Support Initial Teacher Training in the UK. *Mobile Technology: The future of learning in your hands,* Cape Town, South Africa, 182-187.

Wood, J., Price, G., Laird, D., Robertshaw, S. (2002). Mobile devices for breast cancer care: A Personalised Education Information Profiling System (PEIPS). *Proceedings of the European Workshop on Mobile and Contextual Learning*, Birmingham, UK, 30-31.

Zurita, G. & Nussbaum, M. (2002). Mobile Computer Supported Collaborative Learning: MCSCL. *Proceedings of the European Workshop on Mobile and Contextual Learning*, Birmingham, UK, 65.

Using mobile technologies for multimedia tours in a traditional museum setting

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Abstract

Mobile technology was used to deliver learner-centred experiences to visitors at a geology museum without compromising the museum's aesthetic appeal. Two Flash-based multimedia tours were developed for the Hypertag Magus Guide system and trialled with 25 visitors in November 2005. Trial participants found the system fun and easy to use, though they requested headphones in order to hear the audio clearly. Several suggestions were provided to improve the tours including creating stronger links between the tour and the museum's objects and incorporating more interactive and competitive elements. A structured multimedia tour approach is appropriate for visitors who can connect with the museum's narratives, though more flexibility is required to meet the needs of other visitor types.

Introduction

The Lapworth Museum of Geology at the University of Birmingham is one of the pre-eminent geology museums in the United Kingdom. Established in 1880, its collections now number around 250,000 specimens, with particular strengths in vertebrate and invertebrate palaeontology and mineralogy. The collections are characterised by having a particularly large volume of supporting historical information (e.g. documents, photographs and maps), that is housed in the museum's archives. As shown in Figure 1, the principal display area for the collections is the Main Hall of the museum. The Lapworth Museum of Geology is one of only two geology museums in the UK to retain its original Victorian/Edwardian design and fittings.

Figure 1: Main Hall of the Lapworth Museum of Geology, University of Birmingham

The museum is used as a resource by students at all levels of formal education, as well as by adult interest groups and the wider community. Hence, there is a broad variation in the experience and knowledge that visitors both bring to and take away from the museum. In

attempting to provide flexible opportunities to support the range of their visitors, the museum is faced with several challenges. The building's II* listed status, in addition to historical and aesthetic considerations, means that the museum cannot be easily altered or extended. This limits the ability for the museum to easily introduction conventional interactive or multimedia displays. These design constraints also limit the content supporting the objects to a small amount of in-case information and traditional paper-based worksheets.

Learning in Museums

The Museums, Libraries and Archives Council of the UK provide a highly inclusive definition of learning:

> *Learning is a process of active engagement with experience. It is what people do when they want to make sense of the world. It may involve the development or deepening of skills, knowledge, understanding, awareness, values, ideas and feelings, or an increase in the capacity to reflect. Effective learning leads to change, development and the desire to learn more.* (MLA, 2004)

In museums, visitors are encouraged to explore and discover in order to learn the processes of inquiry and even of learning itself (Hawkey, 2004). The ultimate goal of this exploration is the creation of new knowledge and personal meaning - what Falk and Dierking (2000) term 'free-choice learning'. Free-choice learning "tends to be nonlinear, is personally motivated, and involves considerable choice on the part of the learner as to what to learn, as well as where and when to participate in learning" (p. 13). Museums support free-choice learning by helping to reinforce existing knowledge, helping to make abstract concepts 'real' and providing each visitor with a unique experience (Falk & Dierking, 2000).

Previous research suggests that there are patterns in how visitors select and engage with a museum's objects in order to create meaning. A study commissioned for the West Midlands

Science and Industry Collections Project (Morris Hargreaves McIntyre, 2004) revealed four distinct modes of this behaviour:

- **Browsers** first select objects at random and then require explanation. They are likely to select visually arresting objects that appeal to their sense of awe and wonder.
- **Followers** are attracted to the explanatory narratives offered by the museum. These visitors are "keen to feel that they have learned something by the end of their visit." (Morris Hargreaves McIntyre, 2004: 12).
- **Searchers** collect information pertaining to particular collections or exhibits. They are likely to search by keyword rather than by thematic narrative.
- **Researchers** seek information relating to specific objects or a specific subject, including links to authoritative, scholarly commentary and information on the location of related collections.

Browsers and Followers, who made up the largest proportion of visitors in this study, do not need to interact with many objects in order to have a meaningful experience, while Searchers and Researchers want to be able to search across entire collections. Browsers and Followers are likely to prefer information delivered in a rich sensory format, while the principal need of Searchers and Researchers is easy access to detailed information.

Using Mobile Technology to Support Museum Learning

When designing technology for museums, Fernström and Bannon (1997) advocate that the focus should not be on the technology itself, but rather on how the technology may be used to enhance the visitor experience. A common problem faced by museums is that visitors often do not make good use of the range of learning opportunities that they offer. Various reasons have been cited for this, including a lack of preparation and follow-up (Oppermann & Specht, 1999)

and supporting materials that cannot easily adapt to the range of learner interests and needs (Not & Zancanaro, 1998). Mobile technology can support visitors by providing both location-based information and guidance through this information based on the learner's interests and needs.

Museum learning has personal, physical and sociocultural dimensions (Falk & Dierking, 2000). Mobile technology may also be used to build more engaging learning experiences by directly facilitating these dimensions by their personal, portable and networked nature. Previous work has shown that mobile technology can help to increase engagement with the visitor's physical surroundings (Naismith et al., 2005), increase the confidence, motivation and involvement of pupils and staff visiting art museums (Burkett, 2005) and promote interactivity with artworks (Proctor & Tellis, 2003).

The following requirements for the design of mobile technology and content for a general audience were gathered from the literature:

- Technology should be easy to use and unobtrusive; it should enable the experience rather than detract from it (Hawkey, 2004).
- Content should work to direct the visitor's attention to the objects (Fisher, 2005).
- Visitors should be offered choice wherever possible (Falk & Dierking, 2000).
- Visually arresting objects should be incorporated in order to help *Browsers* make the transition to *Followers* (Morris Hargreaves McIntyre, 2004).
- A strong narrative should be provided to help structure the content. Multimedia should be incorporated where possible and appropriate (Morris Hargreaves McIntyre, 2004).
- When using multimedia, ensure that the audio and video is coherent (Proctor & Tellis, 2003).

- The use of specialist language should be avoided where possible. Unfamiliar terms need to be explained (Fisher, 2005).
- Promote engagement with objects through personal challenge (e.g. quizzes) and play (Fisher, 2005).

Aim of this Study

The primary aim of this study was to explore the use of mobile technology to deliver learner-centred experiences to visitors, while retaining the traditional 'look and feel' of the museum.

Methodology

Overview

The Main Hall of the Lapworth Museum occupies approximately 200 m^2. Most prominent are the four large wooden display units, each containing 16 display cases, which are arranged into two rows in the centre of the room. There are 8 additional wooden display units, containing a total of 24 display cases, as well as 60 display cases along the perimeter of the room. Objects may also be placed on temporary displays, or mounted directly to the wall. In total, there are 148 different display cabinets or display areas. The display cases are glass-fronted, and there is usually at least 6 inches between the objects and the glass. Many of the cases have no low voltage power available within them and there are few power sockets available towards the middle of the room (Shucksmith, 2005).

The current configuration of the museum suggests to the visitor an essentially linear path through the museum's displays. This corresponds to viewing the objects in chronological order. Mobile technology, however, affords the opportunity to tell different stories about the museum's objects, without extending or altering the museum's infrastructure.

Study Design

Selection of Positioning Technology

It is important to preserve a "sense of place" when using mobile technology (Exploratorium, 2005). In order to achieve this, appropriate positioning technology was sourced in order to support context sensitive delivery of information and activities based on physical location.

In order to cater to the needs of visitors at different educational levels, content would be provided in the form of tours. A tour would consist of a series of 'stops' that were linked to either specific cases or individual objects. Positioning technology would then be used to identify to which stop the user was closest, in order to provide relevant information.

The small size and compact layout of this indoor museum prevented any serious consideration of absolute positioning techniques, as were used in the CAERUS project with the Winterbourne Botanic Garden (Naismith & Smith, 2004; Naismith et al., 2005), as it would be necessary to determine in which direction the visitor was facing. Instead, various low or no-power 'tagging' technologies were considered. These could be used either at the 'case' level or at the 'object' level. As it would be necessary for the visitor to take some action in 'activating' the tag, it could be fairly certain that the correct location would be identified.

Tour Design and Development

The primary motivation behind the focus on tours was to promote non-linear exploration of the museum. Visitors can also be assisted in the transition from *Browsers* to *Followers* by incorporating some of the museum's visually arresting objects (e.g. the Tyrannosaurus rex) within a narrative theme.

The limited capabilities of the inbuilt browser on Pocket PC handheld devices presented challenges to the development of sophisticated multimedia content in HTML. An alternative to HTML content creation is the use of Macromedia Flash. Flash uses the concept of a movie, and allows control of content layout on a frame-by-frame basis. A simple scripting language can be used to control movement between frames. Flash also has the advantage of supporting the import of media files and producing a single output file, as opposed to the multiple files required with an HTML-only approach.

It should be noted, however, that Flash outputs a file with a SWF extension, which cannot be displayed on the Pocket PC handheld device without additional software. A free ActiveX control from Adobe (http://www.adobe.com/devnet/devices/development_kits.html) can play the SWF file if it is embedded within an HTML file. This control is licensed for development purposes only, and is not available for commercial release.

Visitor Evaluation

The next stage of the study was to evaluate the demonstrator system for efficiency, effectiveness and satisfaction. The objectives of this evaluation were to:

- assess the general usability of the system.
- assess how the system affected user behaviour and ability to navigate around the museum.
- assess desirability of the system amongst different user groups.
- assess desirability of different types of content amongst different user groups.

Twenty-five visitors to the Lapworth Museum participated in a trial of this system in November 2005. Table 1 describes the organisation of participants in the trial.

Table 1: Trial Organisation

Visitor Type	Tour	Number of Visitors
A. Adult Visitors	Climate Change	5
B. Undergraduate Students	Climate Change	6
C. School Visitors	Predators and Prey	14

Eight iPAQ handheld devices were used during the trial, six running the Pocket PC 2002 operating system and two running the Pocket PC 2003 operating system. The Hypertag Magus Guide application and Macromedia Flash Player ActiveX control were preloaded on all devices, along with the content for the particular tour.

Trial participants gathered in a central meeting space for a scripted overview and demonstration of the Magus Guide system. The trial participants were then free to wander around the museum and use the Magus Guide as they wished, though it was suggested that they attempt to follow the tour as set. Informal observations were made while the participants were in the museum. Participants were instructed to return the handheld devices when they had either completed the tour, or were satisfied that they had experienced the full functionality of the system. A short questionnaire was then administered, followed by a semi-structured interview on their experiences.

The trial participants covered a range of demographic groups. Table 2 shows a breakdown of the trial participants by sex, age and experience of the museum. Trial participants spent between 15 and 30 minutes in the museum.

Table 2: Trial Participant Demographics

Sex	Male	21
	Female	4
Age	under 20	14
	20-29	5
	30-39	1
	40-49	0
	50-59	1
	60-69	3
	70-79	1
Experience of Museum	First Time Visitor	11
	Returning Visitor	14

Results

Selection of Positioning Technology

Table 3 provides a summary of the three main technologies evaluated: barcodes, RFID and Infrared.

Table 3: Comparison of Positioning Technologies

	Barcodes	**RFID**	**Infrared**
1. Supplier	Socket Communications	Socket Communications	Hypertag Magus Guide
2. Cost of demonstration kit	Low	Medium	Medium
3. Aesthetic appeal of tags	Low	High	Medium
4. Ease of activating tag	Medium	Low	High
5. Requires reader for each handheld device	Yes	Yes	No
6. Power required for tags	No	No	Yes (battery)
7. Requires additional software development	Yes	Yes	No

Barcodes are an established and familiar technology, and have been used extensively for many applications, including purchasing food and general stock control. Pridden (2003) provides an extensive review of the advantages and disadvantages of using barcodes in a traditional museum setting.

As the barcodes would be placed on the individual cases or objects, the iPAQ would need to be equipped with a barcode reader to identify the code and take appropriate action. A SD-compatible barcode reader, and supporting software, was acquired from Socket Communications (www.socketcom.com). As the iPAQs used in the trial have an inbuilt SD slot, it was possible to use the barcode reader without any additional supporting hardware.

Barcodes were ultimately deemed unacceptable due to a number of factors. Though the process of generating the barcodes is relatively straightforward and inexpensive, it would be necessary to purchase a separate barcode reader for each iPAQ used by the museum. Additional software development would also be necessary to use the barcode number to display the appropriate multimedia content. The barcodes would need to be affixed to the cases with some kind of adhesive, which could potentially cause damage. The barcodes themselves are also easily damaged and, as they are quite familiar in industry, may project a "low-tech impression to most visitors" (Shucksmith, 2005: 5). Barcodes are also "visually intrusive" (Pridden, 2003: 4), which may compromise the museum's aesthetic appeal.

RFID is also used extensive in the manufacturing industry. Hsi and Fait (2005) describe a custom-designed RFID application that was used to enhance visitor experiences at the Exploratorium science museum in San Francisco.

A RFID demonstrator kit was acquired from Socket Communications. A selection of passive (i.e. unpowered) tags was provided, each with a read distance of approximately 2.5

inches. The tags were smaller and more visually appealing than the barcodes. The reader, however, was CF-compatible (as opposed to SD) which required an additional expansion sleeve for the iPAQs. As with the barcode reader, it would be necessary to develop additional software to use the RFID code to display the appropriate multimedia content.

Following the trials, RFID was also deemed unacceptable. The total cost of ownership was higher than that of barcodes, without providing any additional benefits. The iPAQ, expansion sleeve and RFID reader together were quite bulky and difficult to manipulate. The RFID sensor was actually located on the back of the reader, meaning that the user had to hold the iPAQ flat over the tag, as opposed to the more intuitive 'point and click' operation of the barcode reader. The short read distance of the tags meant that it would not be possible to place them in the cases, thus the same problems with affixing the barcodes to the cases would be encountered.

Ultimately, the Hypertag Magus Guide (http://www.hypertag.com/igsolutions.html) system was selected for this study. Fisher (2005) evaluated this system in four different UK museums, so there was already some indication of its possible effectiveness. The Magus Guide system includes custom-designed battery-powered infrared tags, as well as supporting software both to identify the tag and to display the appropriate multimedia content. Infrared capabilities are inbuilt into nearly all handheld devices, and have traditionally been used to 'beam' information from one device to another. This meant that it was not necessary to purchase a reader for each device, which substantially lowered the total cost of ownership. According to Hypertag, the batteries are suggested to last one year under normal operation.

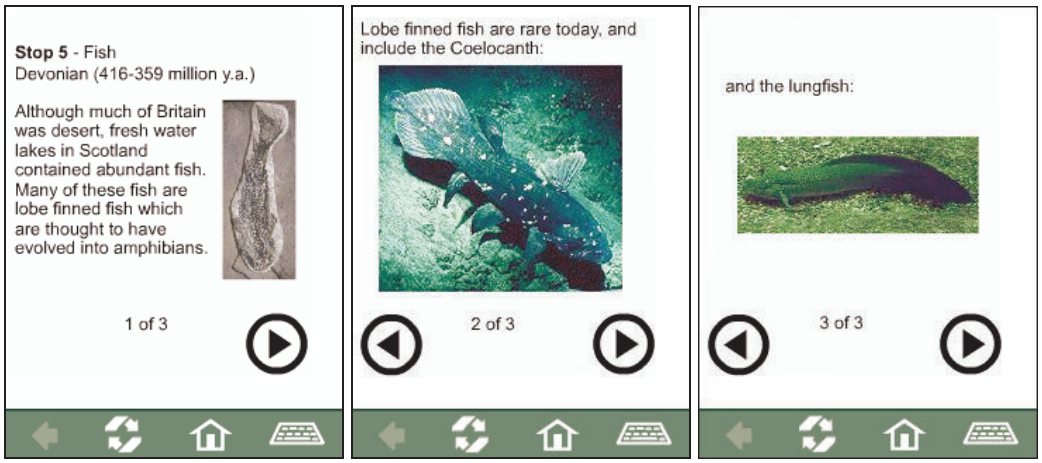
Figure 2 shows a sample tag. Activating a tag required pointing the handheld device at it. When activated, the tag flashed a blue light, accompanied by an audible 'click' in the software

application. As the tags had a read distance of approximately 1 metre, it was possible to place them inside the display cases. In total, 17 of these tags were acquired for this study.

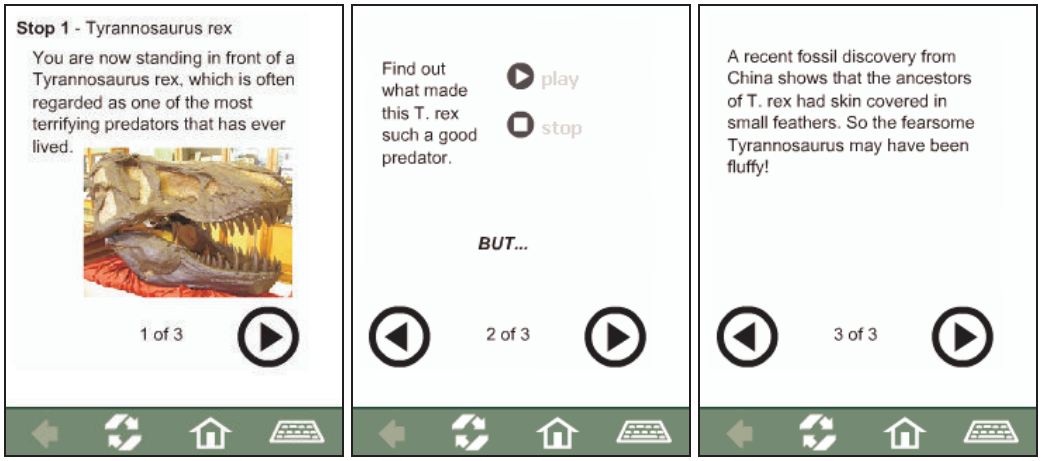
Figure 2: A Sample Magus Guide Tag

Tour Design and Development

Two multimedia tours were developed, a 14 stop 'Climate Change' tour directed at a general, non-specialist audience and an 8 stop 'Predators and Prey' tour directed at a younger, non-specialist audience. The Climate Change tour contained text, images and audio, while the Predators and Prey tour contained text, images, audio and video. Figures 3 through 8 illustrate screen shots from each of these tours.



Figures 3, 4 and 5: Screen shots from the 'Climate Change' tour



Figures 6, 7 and 8: Screen shots from the 'Predators & Prey' tour

As the Lapworth Museum did not have wireless network coverage, it was necessary to store the files on the iPAQs. This is supported by the 'Local Redirect' feature of the Hypertag Magus Guide. It was originally intended that each tour would be developed as a single Flash SWF file and embedded into an HTML file. Code could then be included in the HTML file to play the Flash file at a specific frame. Unfortunately this feature did not seem to be supported on the iPAQ and it was necessary to create a separate SWF file for each stop on the tour.

Visitor Evaluation

Table 4 shows the mean and standard deviation of the response to each questionnaire item, in the range from 1 (Strongly Disagree) to 5 (Strongly Agree). A one sample t-test was performed on each mean, with 3 (Neither Agree nor Disagree) as the constant value. All statements showed a significant difference from 'Neither Agree nor Disagree' ($P < 0.05$).

Table 4: Mean and Standard Deviation of Responses to a 5 point Likert Scale (1 = Strongly Disagree, 5 = Strongly Agree)

Statement	Mean	SD	N
a. Using the handheld device does not require much training.	4.04	1.06	25
b. It was easy at a glance to see what the options were for each screen.	4.38	0.50	24
c. It was difficult to select the option I wanted with the touch screen.	1.88	1.24	25
d. I felt that I was in control of the device.	4.17	1.27	24
e. The device responded too slowly.	1.79	1.18	24
f. I found it difficult to read the text on the screen.	1.92	1.28	24
g. The device helped me to navigate around the museum.	3.88	1.05	25
h. I felt self conscious using the device.	2.17	1.31	24
i. The way that the device presented information was clear and understandable.	4.24	0.78	25
j. It was difficult for me to determine where I was in the museum.	2.17	1.07	23
k. I would recommend the device to other visitors.	4.48	0.79	23

All items are significant at $P < 0.05$

Positive Aspects of the System

Most visitors found the experience of using the Hypertag Magus Guide system to be fun and engaging. Participants were able to stay on task during the trial and did not seem to attempt to use the handheld device for other purposes. They found the action of 'swiping' the tags easy and intuitive and felt that they could use the system independently in the future. The mix of media present in the designed content was highly desirable, particularly the audio segments.

From a management perspective, the tags themselves were small and easy to set up and move around the museum as required. Though battery powered, there was no need to replace any of the batteries during the trial.

Negative Aspects of the System

The audio was very difficult to hear clearly in the changeable environment of the museum, and many trial participants commented on the necessity of headphones. Headphones were also felt to promote a more personal experience and address the potential embarrassment factor of using the system alongside other museum visitors. It was also observed that the application itself is quite noisy, with many clicks and beeps, which could disturb other museum visitors.

The original decision not to offer headphones was made in an attempt to promote social interaction and prevent isolation and a 'heads-down' experience (Hsi, 2003). Proctor and Tellis (2003) identify the same issues in the decision by a museum to offer either a headset or wand for an audio-based tour. They conclude that the decision is a personal choice and that the "effectiveness of these educational experiences is based on the appropriateness of the technology used for the stated educational or interpretive goals".

Aspects of the System that Need Improvement

The introduction to the system was a bit too informal for many participants and there was some initial confusion as to where they should start and what buttons (if any) needed to be pressed. The digital map on the handheld device was both difficult to read and labour intensive to produce. Suggestions to address both of these problems included having a large poster or a handout that both outlines the use of the system and labels the stops in order.

During the trial, the white square tags were sometimes difficult to distinguish from the labels in the cases, and many participants commented that they would have appreciated more obvious visual indicators. They suggested that this could be accomplished by painting the tags in a distinctive colour, numbering the tags or both.

While the content was generally well received, some of the images selected were not well suited for the small display screen. There was also a tendency for participants to become so engaged in the experience of using the handheld device that they did not look at or interact with the actual objects in the cases. Participants commented that this could be remedied through direct instructions (e.g. "Look at the xxx in the case"), stronger linking between the object labels and the information available on the handheld device (e.g. sometimes just the common name was used in the tour, whilst the label contained the scientific name) and incorporating short quizzes. Increased interactivity and competition was particularly desirable amongst younger visitors. This aligns with Fisher's (2005) recommendations for designing content that works with the objects and having a screen that promotes engagement through personal challenge and play.

There was also a need to offer more flexibility within the system. In addition to the logistical problems of having many visitors start at the same place, older visitors were somewhat resistant to following a 'prescribed tour' and wanted to be able to focus their visit on one or two areas of interest.

From a management perspective, installing the software and loading the content onto each iPAQ was quite time-consuming. It was necessary to repeat this procedure for each trial session, as the batteries on the handheld devices sometimes drained completely, losing all of the applications and content in memory.

Age Group Differences

The adult trial group consisted of regular visitors to the museum. Whilst there were some technical problems during this first trial that were later remedied, overall the participants were generally enthusiastic, thought that this system could add to the museum experience and were

willing to try it again. Unlike the younger visitors, however, they felt that they needed someone in the museum to be 'on call' for technical support.

The adult visitors could successfully manipulate the technology but, as noted previously, there was some resistance to the idea of going on a 'prescribed' tour. As specialist visitors, they were more likely to adopt *Searcher* and *Researcher* roles rather than *Browser* and *Follower* roles. There was some concern that the range of visitor needs was going to make it difficult for the museum to cater to everyone.

The group of undergraduate students responded particularly well to the structure of the tour, and quickly adopted the *Follower* role. They felt that this approach helped the content to 'make sense' and that the content was pitched 'about right' for a general audience. There was some interaction between the students during the trial, but it was primarily an individual experience. With respect to the technology, there was some initial confusion about where and how to get started, but by the end of the trial, all of the students felt that they would be able to use the system again independently.

While the undergraduate students felt that this system enhanced the museum experience and made it more fun, they were pragmatic about their likely future usage of it. They would need the system to support them in a *Researcher* role in order that they could use the information provided for projects or essays. In their opinion, this would involve gathering specialist information on a select number of cases rather than a structured tour.

The school visitors were highly engaged by the technology. They immediately gravitated towards the handheld devices and did not wait for a formal explanation, preferring instead to figure it out as they went along.

This large group of 14 was split in two for the trial and very different behaviour was observed between the two groups, possibly due to the presence of the teacher in the second group. Not all of the students seemed to be following the tour, and several observations were made of students adopting a *Browser* role by trying to 'scan' for tags on objects they deemed interesting (e.g. the deer head). They were highly engaged by the device and the content, though their interaction with the actual exhibits was minimal. A common behaviour was to 'swipe' a tag and then find some place to sit and interact with the device.

Students in the school group made several brief, but supportive comments ("good", "really interesting") and the teacher remarked that this system was "the best thing I've seen" for museum visits. The teacher felt that more structure was needed, however, in order to transform it into an effective learning experience. He and the students were very keen on the idea of introducing competitions (with awards) in order to focus attention on the objects and exhibits. The teacher also felt that competitions could be designed in the form of 'levels' in order to cater to students with varying levels of ability. Students also suggested the incorporation of 'weird facts', a finding echoed by Fisher (2005), which may help to appeal to a *Browser's* sense of awe and wonder.

Conclusions

It is feasible and desirable to use mobile technology to deliver learner-centred experiences in the Lapworth Museum of Geology without compromising the aesthetic appeal of the museum. The structured multimedia approach taken in this project is appropriate for visitors who can adopt a *Follower* role, though more flexibility is required to meet the needs of *Browsers, Searchers* and *Researchers.*

The Hypertag Magus Guide provides an easy to use mechanism for visitors of all ages to access web-based content, which can be stored locally on handheld devices in the form of HTML or Flash movie files. It may, however, be necessary to provide headphones in order to hear the audio clearly. Overall, trial participants required minimal technical support and found the use of the system to be fun and engaging.

Limitations

The results of this study are based on a small trial consisting mainly of young male participants. The response of young females to this system is unknown. Additionally, all participants were geology enthusiasts to some degree. It is unknown if this system could be used to engage people with no previous relationship with either the museum or with geology in general.

Acknowledgements

This research was funded through a grant from Microsoft UK Ltd to the Centre for Learning, Innovation and Collaboration (CLIC, formerly CETADL) at the University of Birmingham.

References

Burkett, E. (2005). Using handheld computers to stimulate critical studies in A-Level art. *Becta*. Retrieved November 6, 2006 from http://www.evaluation.icttestbed.org.uk/learning/research/secondary/interest/collaboration.

Exploratorium (2005). What Are You Puzzling About? In *Proceedings of Electronic Guidebook Forum 2005: Issues and Questions about Wireless Learning Technologies and Handheld Computers in and beyond Museums*, San Francisco, CA.

Falk, J. H. & Dierking, L. D. (2000). *Learning from Museums: Visitor Experiences and the Making of Meaning*. Walnut Creek, CA: AltaMira Press.

Fernström, M. & Bannon, L. (1997). Enabling Technology for Museum Visitors: Issues and Experiences. In *Proceedings of the International Conference on Museums and the Web 1997*, Los Angeles.

Fisher, S. (2005). *An Evaluation of Learning on the Move and Science Navigator: Using PDAs in Museum, Heritage and Science Centre Settings*. London: NESTA.

Hawkey, R. (2004). *Learning with Digital Technologies in Museums, Science Centres and Galleries.* Bristol: Futurelab.

Hsi, S. (2003). A study of user experiences mediated by nomadic web content in a museum. *Journal of Computer Assisted Learning, 19,* 308-319.

Hsi, S. & Fait, H. (2005). RFID Enhances Visitors' Museum Experiences at the Exploratorium. *Communications of the ACM, 48(9),* 60-65.

MLA (2004). *inspiring learning for all*. Retrieved October 22, 2006 from http://www.inspiringlearningforall.gov.uk.

Morris Hargreaves McIntyre (2004). *Learning Journeys: Using technology to connect the four stages of meaning making*. Manchester.

Naismith, L. & Smith, P. (2004). Context-Sensitive Information Delivery to Visitors in a Botanic Garden. In *Proceedings of ED-MEDIA World Conference on Educational Multimedia, Hypermedia and Telecommunications*, Lugano, Switzerland.

Naismith, L., Sharples, M. & Ting, J. (2005). Evaluation of CAERUS: a Context Aware Mobile Guide. In *Proceedings of mLearn 2005 - Mobile technology: The future of learning in your hands*, Cape Town, 112-115.

Not, E. & Zancanaro, M. (1998). Content Adaptation for Audio-based Hypertexts in Physical Environments. In *Hypertext '98: Second Workshop on Adaptive Hypertext and Hypermedia,* Pittsburgh: ACM, 27–34.

Oppermann, R., & Specht, M. (1999). A Nomadic Information System for Adaptive Exhibition Guidance. In *ICHIM 99*, Washington, DC: Archive*s* & Museum Informatics, 103-109.

Pridden, I. (2003). Object tagging at the Petrie Museum. Retrieved March, 1, 2005 from www.petrie.ucl.ac.uk/barcodes.pdf.

Proctor, N. & Tellis, C. (2003). The State of the Art in Museum Handhelds in 2003. In *Proceedings of Museums and the Web 2003.* Toronto: Archives & Museums Informatics.

Shucksmith, J. (2005). *Proposals for the Lapworth Museum Project: Thoughts and comments on how to create an interactive environment for the visitor within the Lapworth Museum*, Wave Solutions, University of Birmingham.

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Personalized Profiling and Self-Organization as strategies for the formation and support of open m-learning communities.

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Abstract

Mobile and wireless technologies are globally aware therefore so to do institutions have to think globally. By this is meant not simply making learning objects available to international students, but inventing ways to engage students from any geographical location with these objects in such a way that the outcome is knowledge.

This paper explores the applicability of personalized profiling as a means to link students studying similar disciplines to each other, and proposes a self-organizing 'living systems' model that aims to overcome present impediments to the creation of sustainable, 'open', m-learning communities.

'Open' m-learning communities are characterized by their ability to self organize and adapt to changing circumstances. Their conceptual framework is systems theoretical, which draws on understandings about the natural world from the biological and physical sciences. Concepts such as "open structure", "self organization" and "living systems", have currency in the discourses of information and computing sciences (i.e., the research fields of artificial life and artificial intelligence). In the biological scientific view, the sole purpose of a living organism is to renew itself by opening itself up to its environment, or to another structure. In natural scientific terms, an organism that is in equilibrium is a dead organism. Living organisms continually maintain themselves in a state far from equilibrium, which is the state of life.

The transfer of understandings about the operations of living systems is evident in the approaches of computer game designers and programmers, where "swarming" and other empathetic behaviours of organisms such as bees, fireflies and even stem cells, provide the basis for the design of software to support massively multi-user on-line gaming. This new knowledge may have applicability in new approaches to m-learning, for example, through learner self-profiling and the automated matching of learner profiles to other learners and learning opportunities. The first step in this process is that of understanding how the specificities of emerging mobile and wireless technologies might facilitate open m_learning and the formation of m-learning communities.

Key Words: m-learning, personalized profiling, self-organizing systems, mobile learning communities

Personalised Profiling and Self-Organisation as strategies for the formation and support of open m-learning communities.

Introduction:

The mission of ‘open’ universities - to be open to everyone whatever their background, and to provide flexible learning choices to meet life and study needs – means that that the conditions within which they operate are neither fixed nor stable. In this sense, Open Universities are like living organisms. According to the theory of living systems (Capra, 1997) the sole purpose of an organism is to renew itself by opening itself up to its environment or another structure. [1] In an environment dominated by the forces of technological and structural change, organisms that survive are those capable of co-evolution. Thus universities 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.

Specificities of the Mobile Mode

By focusing on the specificities of the mobile mode - technological, structural and systemic - universities can ‘open’ themselves to the m-learning environment, and evolve as part of its ecology. Such features as lower unit cost, miniaturization, wearability, ‘always on’ status, increased data storage capacity, programmability, and multi-media-capability in cell phones have grown a critical mass of student-users who no longer need to physically access CPUs. This signals a transition in the dominant communication mode from ‘e-‘ (electronic) to ‘m-‘(mobile).

Whilst the growth in cell phone uptake, and the phenomenon of ‘always on’ are attributable to economic structural and systemic change (from mono to multifaceted marketing. [2], and from time-based to data-download rating system) the ‘invisible engines’ driving innovation and industry transformation are software platforms (Evans et al, 2006). Application Programming

Interfaces (APIs) in combination with evolving markup language forms, e.g., WML (wireless) and XML (extensible) which deliver information to wireless devices (Gralla, 2005), and DIAL (Device Independent Authoring Language) for authoring mobile content software that will work on different hand-held devices (of which there are more than 2,500) (Boulton, 2006) have brought web-browsing capabilities to miniature hand-held displays. Arguably, software platforms have effectively made cell phones the interface between individuals and their 'worlds'.

An economy of multi-literacies:

New demands for speaking, reading, and writing new media texts which use multiple information modes 'on the fly' in meaningful ways, requires us to be multi-literate. The evolution of low-end, mobile multimedia production, reproduction, and dissemination technologies and systems has made Internet TV a reality (c.f. Current TV[3.] and YouTube). Emergent mobile cultural and social behaviors, codes, and conventions with origins in gaming and diary genres, coupled with multifaceted marketing, have evolved around VC2 (viewer created content). Current TV's VC2 encompasses consumer-provided news, movies and advertisements – now derived from 'on the fly' recording and sharing of experiences and symbolic expressions in the form of cell-flicks (mobile phone video productions).

The education system is founded upon this innate (human) need to make sense of and record our responses to the world through symbolic expression (as culture), and have our creations affirmed in society. Structural adaptation to the mobile mode is evident in lecture theatres and classrooms, where interactions between teacher and learner, and among learners is increasingly mediated by a spectrum of miniaturizing, wirelessly operated hardware, from cell phones and PDAs to laptops and Smartboards™.

Our participation in technologically-mediated, multi-modal learning and communication requires the development of multi-literacies (The New London Group, 1996). A compulsory course in Griffith's undergraduate teacher-education program (Multiliteracies in Education) that we have co-developed, with the contributions of peers and students, addresses this need by engaging students in deconstructing, reconstructing, and transforming meaning in multimodal, multimedia infotainment and edutainment texts. The emphasis is on recognizing what and how learning takes place as children and adolescents engage with these media, and on the students' own learning. Students use e-portfolios to provide evidence of learning in this practical and creative course.

Building Mobile Open Learning Communities

Early Internet community authority, Howard Rheingold (Whole Earth 'Lectronic Link) and others have argued that assumptions that 'community' will automatically form on the basis of embedded broadband services and advantageous telecom partnerships are misguided (Rheingold, 1996; Riva, Davide, & Ijsselsteijn, 2003). Ubiquitous computing and the quick up-take of technological advances such as the 802.11b standard (also known as WiFi) made obsolete the notion of the 'wired community'. The freely available radio spectrum can now be used to network neighborhoods, small businesses, organizations and institutions, even whole towns, through co-operation and a willingness to share resources (Flickenger, 2003). In the era of wireless mobile computing and connectivity, it is possible for learning-communities to transcend not only cultural and geographical boundaries, but also institutional boundaries. For example, m-learning communities could comprise 'roaming' students capable of self-organizing into 'swarms' around learning opportunities. Students would engage with each other in self-directed discussion, exchange information or points of view, or work together on formal assessments.

Mobile technology and instant messaging provide conduits for students engaging with their worlds and the worlds of others around them (Sharples, 2005). Thus we need to consider how best to support learning (as it evolves through social networking) that may be not only trans-institutional, but also transient. We can anticipate a future where students may 'bank' units or modules with a variety of learning service providers, possibly worldwide, toward an accredited qualification or program.

These aspirations, however, must be tempered by the fact that the extent of user agency is a significant factor in enlisting acceptance of a new tool, system, or environment. A commitment to 'designing with' (rather than 'designing for') could be supported with the introduction of strategies derived from community development and its close relative, community cultural development - fields characterized by a focus on social good, commitment to human rights, and community cohesion. A multi-disciplinary pedagogy that is values and problem-based, would be required to address inhibitions to community formation arising from power differentials.

The significance of digital convergence and computer networking for education was quickly recognized, with The National Institute of Multimedia Research (NIME) established in Japan in 1978 to support educational reform in higher education institutions, and the sharing educational resources worldwide. A collaborative e-learning network is in place, with federated searching enabling information retrieval via NIME and ARIADNE, the European learning gateway (Oblinger, 2006). Japan and Europe are partnered with Australia (education.au), Canada (LORNET) and the United States (MERLOT) to form the GLOBE (Global Learning Objects Brokered Exchange) portal that provides searching across all five repositories (GLOBE, 2006). Software platforms facilitating interoperability and digital rights management (DRM) have encouraged data-banking of intellectual output in the form of learning object repositories. Work is

currently underway on the development of national standards in primary, secondary and further education in Australia, and in the tertiary sector the contribution of a unit of learning to an accrediting institution's graduate profile is now identified and published. However how education providers might productively and profitably connect m-learners to shared or open source databases for accredited programs remains a challenge.

A move toward meeting this challenge could be taken through an approach that is systemically aware of, and capable of 'structural coupling' in order for open learning to evolve as part of the mobile ecology. Entrepreneurs adopting this approach have created and grown new industries based on their recognition and co-option of how the mobile mode as effectively turned always-on cell-phone users into listening and tracking devices (Pesce & Fraser, 2005) that already self-generate consumption and activity profiles, and identify 'friends' (Nokia, 2005). Such 'coupling' has yet to be exploited by 'knowledge' industry entrepreneurs.

Personalised Profiling:

In the past 5 years support has grown for student-managed learning profiling through the introduction of electronic portfiolios (ePortfolios). In Griffith University's Education and Arts Faculties, students are required to collect, store and share their learning materials and resources for evaluation and report back, and for later reference as they progress through their studies or in their early careers. These institutional portfolios are organized in terms of graduate attributes desired by the profession, and are subsequently used to secure employment. Similar demands have now been placed on academics to provide web-based 'evidence' portfolios covering teaching, research and service activities to serve the dual purposes of promotion and government operational funding.

M-learning Profile > Object

Affordances and barriers currently exist to m-learning design. The capacity for personalization or customization of content presentation and delivery that has long been associated with website design can support learner-managed profiling. Users choose their style or interest area using individual design attributes through the use of tags, and website content is timely, delivered via email or SMS when created or updated. [In limited learning environments so far - largely just-in-time learning in large corporations - this concept, also known as the IBM-coined term of profiled notification (von Koschembahr & Sagrott, 2005), alerts employees of new downloadable learning materials via cross-referenced data in their human resource (HR) profile.] Furthermore, it is possible now for content to be matched to pre-determined learning profiles, as learning objects are already tagged with metadata for categorization and searching within university digital repositories.

To facilitate the sharing of student-provided content, consideration would need to be given to the provision of spaces within existing, or alternative, digital repositories for tagged learning materials. As well, barriers such as the gatekeeper against shared access to learning objects by a particular institution's learning management system (LMS) would need to be removed, and associated security issues resolved. Blackboard™ (an increasingly preferred LMS in the global market, including K-12 and further education) currently has a limitation whereby students are unable to upload to its content management system. Open source LMS, Sakai, however, has an enabling feature for publishing and searching through user profiles that are made for public access.

A model for m-learning designed with profile matching and learner created content as its basis would anticipate that as learners begin to access multiple repositories, form learning

communities, become more independent, more globally-aware and more savvy network navigators, their profiles take on more importance and functionality. Thus it would be necessary to think beyond personal preferences and rules for customized content or RSS subscriptions. Using a principle behind context-aware (’listening’) systems, which underpinned an innovative just-in-time information provision via cell phone for museum visitors (Kusunoki et al, 2002) the interface would follow the user not the other way around. The m-learner's evolving profile would follow the user, morphing dynamically.

In the model we are proposing (see Figure 1 below), the profile becomes an entity in itself, a dynamic network package that continually grows, expands, catalogues and tracks a student’s journey or learning trail (Walker, 2006) as they acquire, construct, deconstruct and reconstruct knowledge and experience. Metadata on a student's interaction, participation, task and activity completion, and information sources visited or referenced, is written to their profile. The source, text, image or sound files developed as a result of the learning interaction are stored on the member's preferred server, as server space is now as inexpensive as $US7.95 per month (Dreamhost, 2006). A student’s learning object itself can then be viewed via a web browser or similar viewer applications for smaller mobile devices. A student's chosen pathway through knowledge is tracked and cross-referenced and intertwines with the pathways of other learners. At these junctures, opportunities for learning interactions alert the learning community of new activity, which in turn mobilizes those interested members to swarm.

Soon the profile swells to become a learning passport, able to be checked against the requirements for completion of courses at any institution; as prerequisites to enrolment at further institutions or other learning communities. For the community, the morphed profile takes on its most precious of roles yet as an open learning object.

Conclusion: A 'Living Systems' Model

Rather than treat technology in fixed and abstract terms, as a tool or thing to be 'embedded' in the human life-world, it may be more productive to view technology from a systems perspective, as set of ideas circulating via feedback loops, according to a *Living Systems* model of social organization (Nalder, 2002). A living system is a complex, multiply-interconnected network whose components are constantly changing, being transformed and replaced by other components. "*Complexity theory* provides insights into the behavior and emergent properties of social systems" supporting "the familiar patterns of interaction and collective organization that characterize the voluntary and community sectors" (Gilchrist, 2000:264-75).

Education institutions open to structural and environmental change which is re-organizing human-technology-world relations in mobile mode share several attributes for survival with living organisms. A 'living systems' operational model, such as that evident in the games industry - where 'swarming' and other empathetic behaviors of organisms such as bees, fireflies and even stem cells, provide the basis for the design of software to support massively multi-user on-line gaming, and an economy based on freely distributed software supporting consumer created content – would seem an appropriate one to adopt for our purposes.

A globalizing knowledge economy calls for pedagogical and learning support innovations that draw from and contribute to the mobile ecology. Innovation that ensures renewal relies on distributed creativity and networking to maintain feedback loops. Customized APIs are key 'engines' of the mobile ecology within which both teachers and learners are now embedded. These 'invisible engines' can bring both together 'on-the-fly' to form self-organising m-learning

communities, by matching learner self-profiles and learning opportunities, irrespective of geographical location. A framework exists to support a global accreditation ‘passport’ approach to open university qualifications for m-learners, using the theoretical framework and learning>object model described here.

References

Boulton, C. (May 16, 2006) "W3C Turns Up 'Dial' For Mobile Content", Internet News Retrieved 5 July, 2006 from http://www.internetnews.com/dev-news/article.php/3606566

Capra, F. (1997) *The Web of Life: A New Synthesis of Mind and Matter* London: Harper Collins, p 177

Current TV (n.d.) Retrieved 4 August, 2006 from http://www.current.tv/about

Dreamhost (n.d.) Retrieved 22 September, 2006 from http://www.dreamhost.com/

Evans, D.S., Andrei Hagiu & Richard Schmalensee (Eds) (2006) *Invisible Engines: How Software Platforms Drive Innovation and Transform Industries.* Cambridge & London: MIT Press (

Flickenger, R. (2003) *Building wireless Community Networks*. O'Rielly Publishing. http://www.oreilly.com/catalog/wirelesscommnet2/

GLOBE (n.d.) Retrieved 16 September, 2006 from http://globe-info.org/globe/go

Intel (n.d.) Retrieved 22 September, 2006 from http://www.intel.com/research/exploratory/location.htm

Gilchrist, A. (2000) "The well-connected community: networking on the edge of chaos." *Community Development Journal* #35 Oxford University Press: Cambridge, pp 264-275.

Gralla, P. (2006) *How Wireless Works.* Indianapolis, Que

Kusunoki F., Sugimoto M., Hashizume H. (2002) "Toward an Interactive Museum Guide System with Sensing and Wireless Network Technologies", *Proc. of IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE 2002)* , (p. 99-102), Växjö, Sweden, August 2002

Nalder, G. (2002) *Realising the Virtual: the Internet as a space for transformatory art practice.* Doctoral Dissertation, Creative Industries Research and Applications Centre, Queensland University of Technology.

Nokia (2005) *Nokia Sensor system* How to meet new friends (Flash™ Animation) Retrieved 5 August, 2005 from http://www.nokia.com/nokia/0,,73651,00.html

Oblinger, D. (2006). "Sharing Educational Resources Worldwide. An interview with Shimizu Yasutaka." *EDUCAUSE Review*, vol 41, no.4, pp. 44-48

Pask. G. (1975). "Minds and media in education and entertainment: some theoretical comments illustrated by the design and operation of a system for exteriorizing and manipulating individual

theses," in *Progress in Cybernetics and Systems Research*, vol. IV, R. Trappl and G. Pask, Eds. Washington and London: Hemisphere Publishing Corporation, 1975, pp. 38-50.

Pesce, M. & Fraser, A. (2005). "The Telephone Repair Handbook", paper presented at the Australasian Conference on Interactive Entertainment, November, Sydney. Retrieved 24 July 2006, from http://www.interactive.edu.au/BluOpen/trh.pdf

Riva, G, Davide, F. & Ijsselsteijn, H.J (2003) *Being There: Concepts, effects and measurements of user presence in synthetic environment* IHOS Press: Amsterdam.

Sharples, M. (2003). Disruptive Devices: Mobile Technology for Conversational Learning. *International Journal of Continuing Engineering Education and Lifelong Learning*, 12, 5/6, pp. 504-520.

Sharples, M. (2005) Learning As Conversation: Transforming Education in the Mobile Age. *Proceedings of Conference on Seeing, Understanding, Learning in the Mobile Age, Budapes*t, Hungary, pp. 147-152. Also published in Kristóf Nyíri (ed.) (2006) *Mobile Understanding: The Epistemology of Ubiquitous Communication*.

The New London Group (1996) "A pedagogy of multiliteracies: Designing social futures" in *Harvard Educational Review.* Vol 66 #1. Cambridge, pp 60-92.

Von Koschembahr, C. & S.Sagrott (2005). "The future of learning at IBM: empowering employees through mobile learning" in Kukulska-Hulme, A. and J. Traxler (Eds.), *Mobile learning. A handbook for educators and trainers.* Oxford: Routledge, (pp 164-172).

WC3 Device Independent Authoring Language (DIAL)
http://www.w3.org/TR/2006/WD-dial-20060516/

Walker, K. (n.d.) *Learning Trails*. Retrieved 16 September 2006, from http://www.lkl.ac.uk/people/kevin/trails.html

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Footnotes

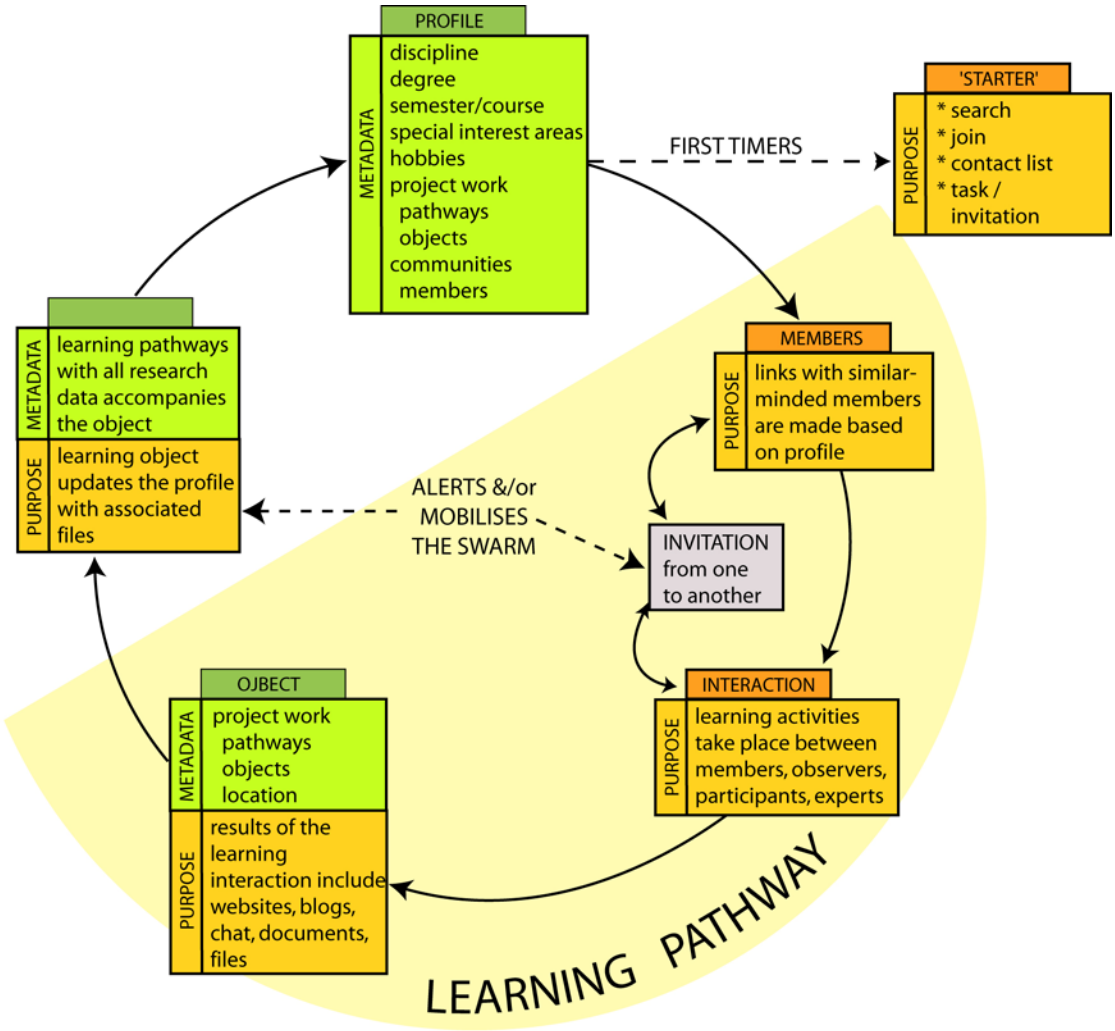
[1] . Physicist, Fritjof Capra (1997:177) (who has attempted to synthesise recent scientific breakthroughs such as the theory of complexity, Gaia, chaos and other explanations of the properties of organisms, social systems and ecosystems) explains: "… an organism in equilibrium is a dead organism. Living organisms continually maintain themselves in a state far from equilibrium, which is the state of life ... as we move away from equilibrium we move from the universal to the unique, towards richness, and variety. This, of course, is a well-known characteristic of life."

[2] Internet economics expert, David Evans, explains how multifaceted marketing evolves, beginning with the familiar one-sided marketing strategy "give away the razor and sell the blades" evident in the pricing approaches of businesses such as TiVo, who embedded an "invisible engine" in their digital video recorder. The recorder was priced low to grow an initial market of revenue paying subscribers who wished to record television shows but skip the commercials. These customers were then used to attract two other sides, one using the strategy of providing tools and offering prizes for the best applications in several categories, including games, music, and photos", and the other providing an opportunity for advertisers to "provide creative services to users. Viewers can select advertisements they are interested in and can download infomercials and other more detailed product information that they can't get in a 30-second spot." (Evans et al, 2006, p339)

[3]Current TV is a VC2 (Viewer Created Content) channel that has evolved through an understanding of the specificities of both APIs (Application Programming Interfaces) and multifaceted marketing. Current TV's attraction is that their content is flowing in both directions, as users are able to upload newsworthy and entertaining video-clips as well as create prize-winning advertisements for the channel's advertisers.

Figure Captions

Figure 1. Learning profile<->object.



Ubiquity and Reusability

Judy Nix, Ericsson

Ubiquity and reusability are key factors in driving the deployment of content. Up to now these elements have been challenges within mobile learning. However, with the advent of metadata structures, new technologies and mobile platforms, ubiquity and reusability are becoming a reality. It is important when introducing new learning platforms such as mobile learning that money and time is not spent creating complex ways to extract material that is already available in legacy systems.

Learning is moving from being teacher centric to learner centric. Ericsson is in the transitional phase, moving towards Personal Learning Environments whereby students will learn on the platforms which best support their learning styles.

The paper outlines the development of Ericsson Education's learning content deployment strategy for instructor led, elearning and mobile learning.

Ericsson's Training Situation

Ericsson designs and deploys telecommunication infrastructure / networks. Ericsson is the largest supplier of mobile systems in the world. The world's 10 largest mobile operators are among Ericsson's customers and some 40% of all mobile calls are made through Ericsson systems. Sony Ericsson is a joint venture between Sony and Ericsson to develop mobile handsets.

Ericsson is involved in the provision of learning services to its global customer base. Ericsson has world-class learning consultants globally supporting operators with the right competence at the right time. Ericsson's learning services ensure optimal return on investments by supporting the operators in planning, managing and delivering the right competence development according to their business goals. Our numbers speak for themselves. We train and educate up to 75 000 operator employees yearly. We have a network of 28 Training Centers worldwide and we delivered 285 238 student days in 2005. Currently Ericsson offers 714 course titles in different functional areas or job-categories across 400 course flows, covering different competence levels ranging from basic to advanced.

The delivery methods Ericsson offer include:

- Instructor-led training, or Classroom training
- eLearning
- Online services including scheduling, training reports etc
- Remote access training, where a customer trains on Ericsson equipment without having to leave their own country
- Virtual Classroom Training using online collaboration tools

- Blended Training solutions, where various types of training can be grouped; for example using elearning courses as a prerequisite to sitting instructor led courses

Blended Training involves a multi-faceted approach, using multiple types of training products, delivery and systems support. It begins with the development process; balancing the knowledge and skills requirements, appropriate training methodology and suitable delivery methods resulting in a mixed or blended training approach.

This is set against a rapidly changing technology background where courses can be either revised, updated or customised a number of times during a year. The changing technology background is evident to the "man in the street" through network speeds/services deployed by telecommunication operators.

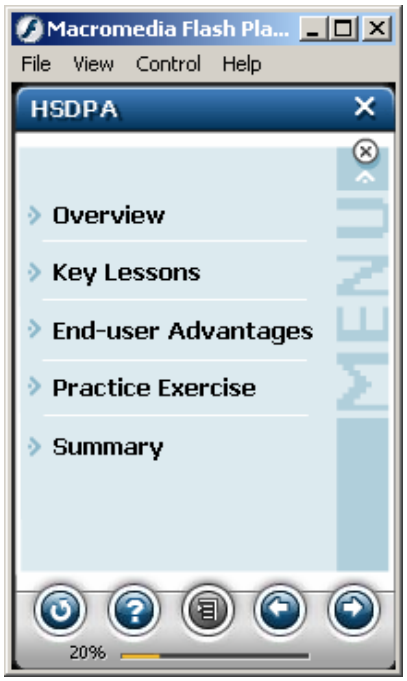
The challenge, then, is to be able to deploy all of this course material in a logical and professional way and to ensure that the quality and the relevance of the training content are paramount at all times. There is also a need of reuse of content, particularly for course material with gives an overview of a topic; the same text that is used in a classroom setting to describe a GSM network can be reused in an elearning course.

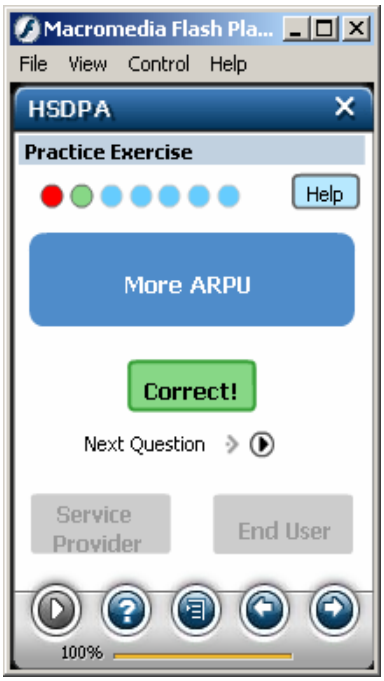
Background

Up to now Instructor Led Training (ILT) / classroom course material has been developed according to a Learning Product Development (LPD) process. This process provided for modularity, so allowed the reuse of some content. However, is has been identified that a Learning Content Management System (LCMS) would greatly increased reusability and cut down on development time.

eLearning students access course content on a PC via any variety of web browsers. As a result, traditional software development processes were used to create eLearning course content, testing for a number of platforms and web browsers. This would often lead to multiple deliveries of a course; for example, course content developed and tested in Internet Explorer would often have to be adapted to run in Netscape or Firefox browsers, due to their differing implementations of the DOM (Document Object Model). This then created a problem for content developers; specific versions of courses were created, stored and deployed across the various platforms, with detection carried out on the fly. Many content developers created content entirely in Flash or Authorware to deal with this issue; however this was not ideal for some training situations. For example, many companies lock down their IT infrastructure to prevent plugins being run, or network speed is not sufficient to allow students to access such media rich content.

mLearning has been at project stage up to recently. Content has been developed and deployed successfully using WAP, html and flashlite on smartphones





The wanted position has been the ability to deploy courseware to “ordinary” phones i.e. phones in common usage. As Ericsson is a provider of training to different Telecommunication Operators across the world who themselves operate in a multi-vendor world, it is impossible to designate a mobile learning phone. It is important to be able to target as many different phones as possible across all network categories.

To summarise, Ericsson has been developing courseware in three different silos to cater for ILT, eLearning and to a very small degree mLearning.

Market Situation

Ericsson announced in July 2005 that ownership of mobile devices had reached 2 billion for the first time. They forecast that ownership would reach 3 billion as early as 2010. This could happen earlier as the figure is in September 2006 reported to be 2.5 billion. This is for a world population of just over 6 billion.

Penetration of mobile devices in European countries is in the high 90% range and is fast approaching 100% as the following statistics show:

Country	Mobile Phone Penetration
Austria	103%
Belgium	88%
Cyprus	107%
Czech Republic	111%
Denmark	101%
Estonia	96%
Finland	102%

France	79%
Germany	91%
Greece	100%
Hungary	92%
Ireland	101%
Italy	111%
Latvia	96%
Lithuania	96%
Luxembourg	107%
Malta	107%
Netherlands	102%
Norway	106%
Poland	71%
Portugal	99%
Slovak Republic	85%
Slovenia	44%
Spain	94%
Sweden	113%
UK	108%

Data sources: WCIS (World Cellular Information Service) and Ovum.
Valid at end of December 2005

The barriers that previously hindered training delivery on mobile devices, such as network speed and handset capabilities have been overcome; the mobile handset has caught up with the PDA in terms of its computing power and media capabilities. This also means that traditional telephony is no longer the only use of these devices.

LMS & LCMS

Ericsson uses Sumtotal's Learning Management System to store, schedule and support training delivery. In tandem it also employs a Learning Content Management System (LCMS) from Giunti Labs. The LCMS allows the user to create and author courses. The LCMS facilitates the collaboration of several different authors on any given course. In addition, the components that make up a course can be centralized and shared across multiple courses. This tool allows developers to bundle learning objects together to create a course; a learning object is defined as any training-related content stored in the system. For example, a learning object can be a single image depicting a network diagram, or could equally represent an entire module of a course.

SCORM is used to tag training content in the LCMS; this applies equally to mLearning, eLearning and instructor-led training. For example, any Instructor-led (ILT) course has associated slides and student text books that need to be tagged and stored. It is also used to structure metadata and modules for reuse.

The metadata that is applied to content must be highly structured and clearly laid out. For example, each content area is tagged, within that individual modules are tagged, and so on down to individual elements such as an assessment, diagram, audio file and so on.

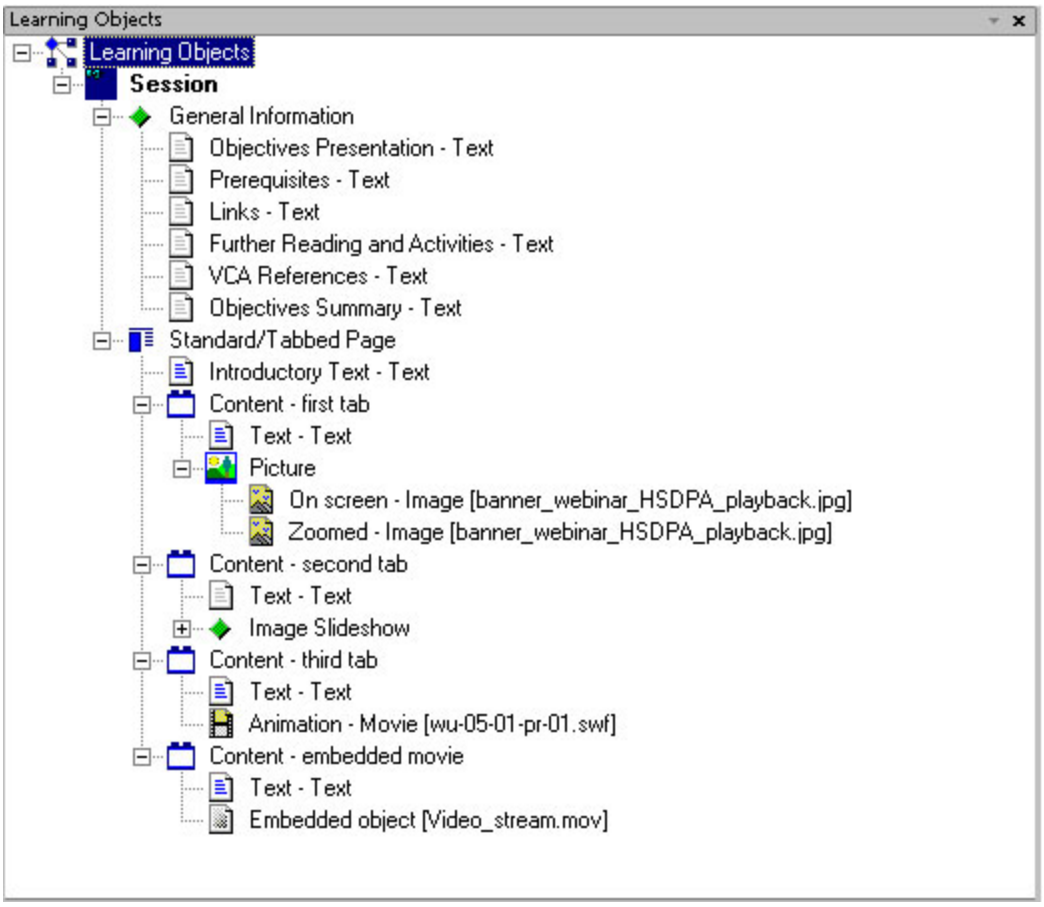
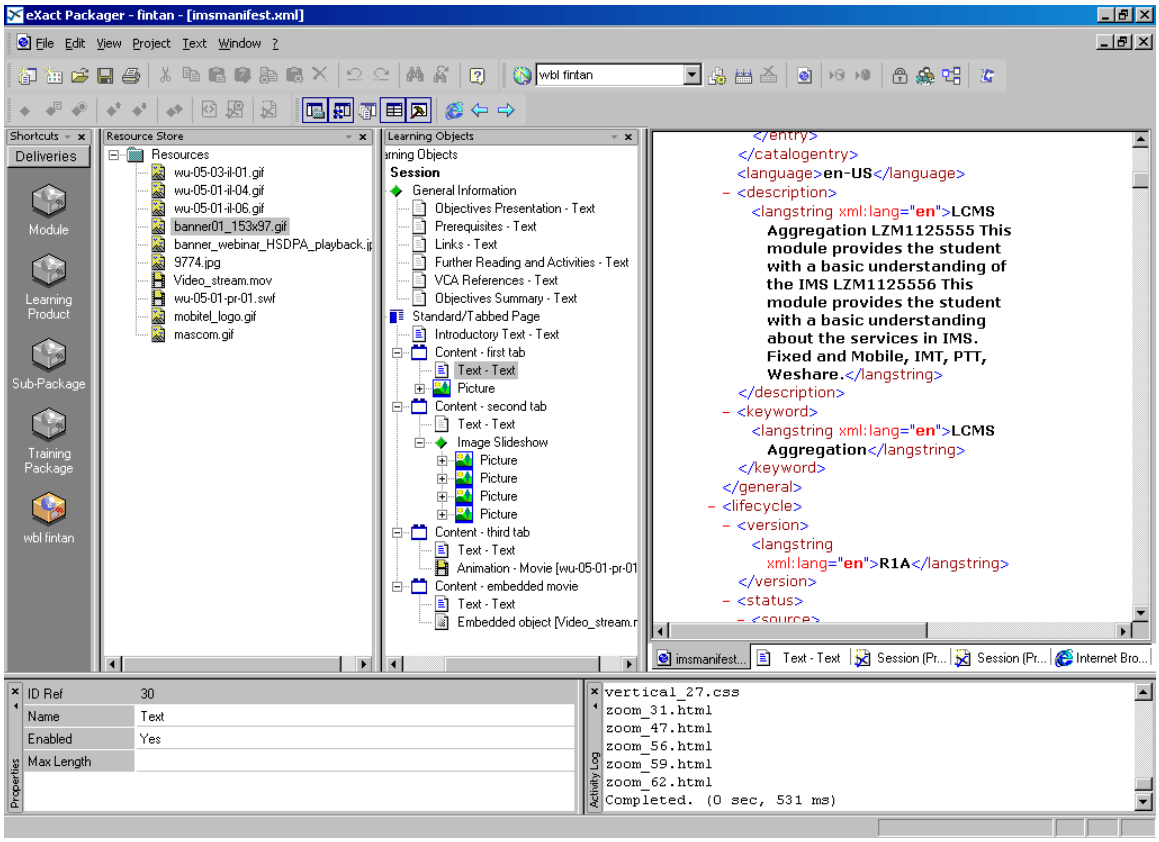


Fig. 1: A course outline in the LCMS

To allow for the use of multiple devices a number of templates are applied to the training content; for example for a mobile phone, a J2MEE template can be applied that will package the content in such a way that it can be downloaded and used in the same way one would download a game or ringtone.

Creating Course Content

In the LCMS, correctly tagged content is identified and grouped according to the needs of the audience at hand. A course developer bundles all of the resources in the system into a session which is then itself edited to insert metadata describing various aspects of the delivery.



Gary for replacement fig – preview of eLearning course

Fig.2: Course development in the LCMS

This metadata can include information about the subject area, the target audience, learning objectives and so on. It is also possible to add metadata for each individual element in the session – this is useful for example where you need to describe an individual animation or graphic in more detail. The level of tracking of the session is also set at this point; individual files can be tracked if required.

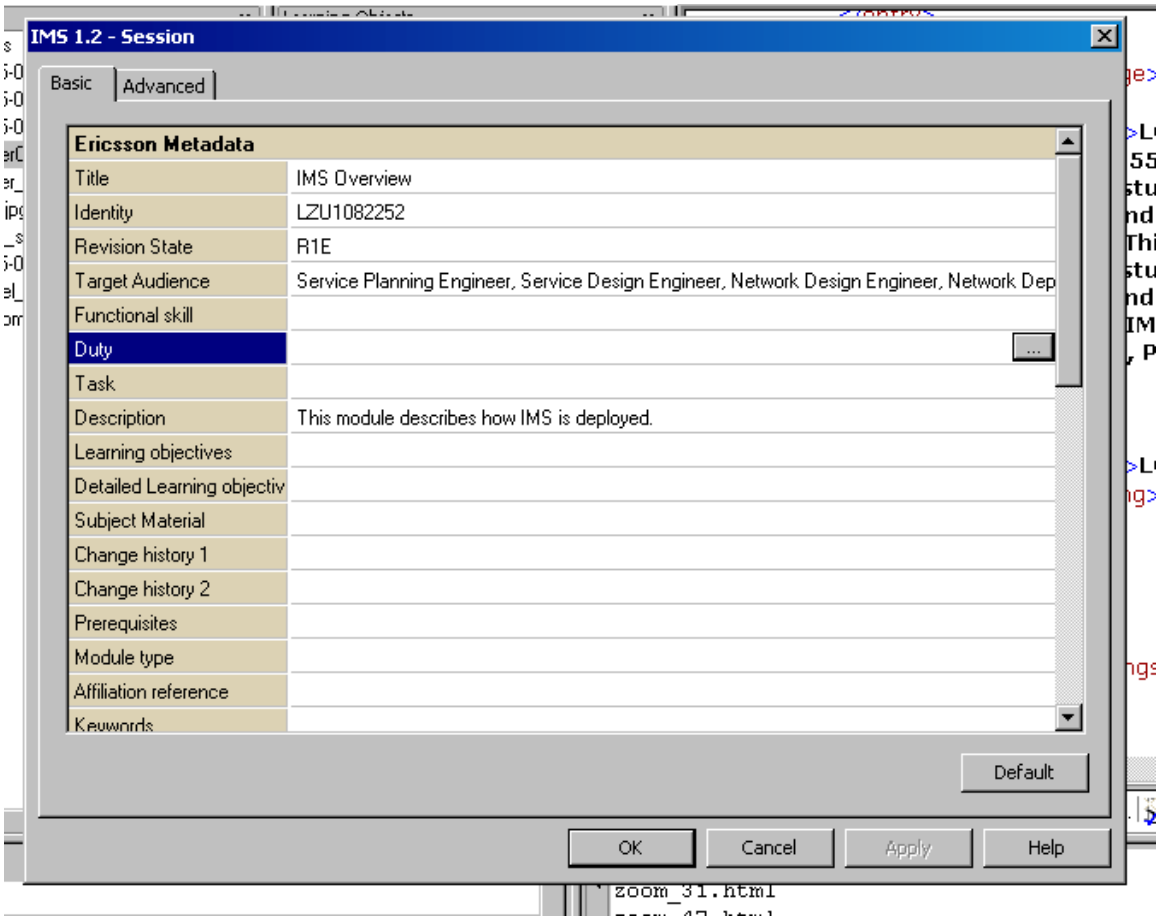


Fig. 3: Entering metadata

Reusability

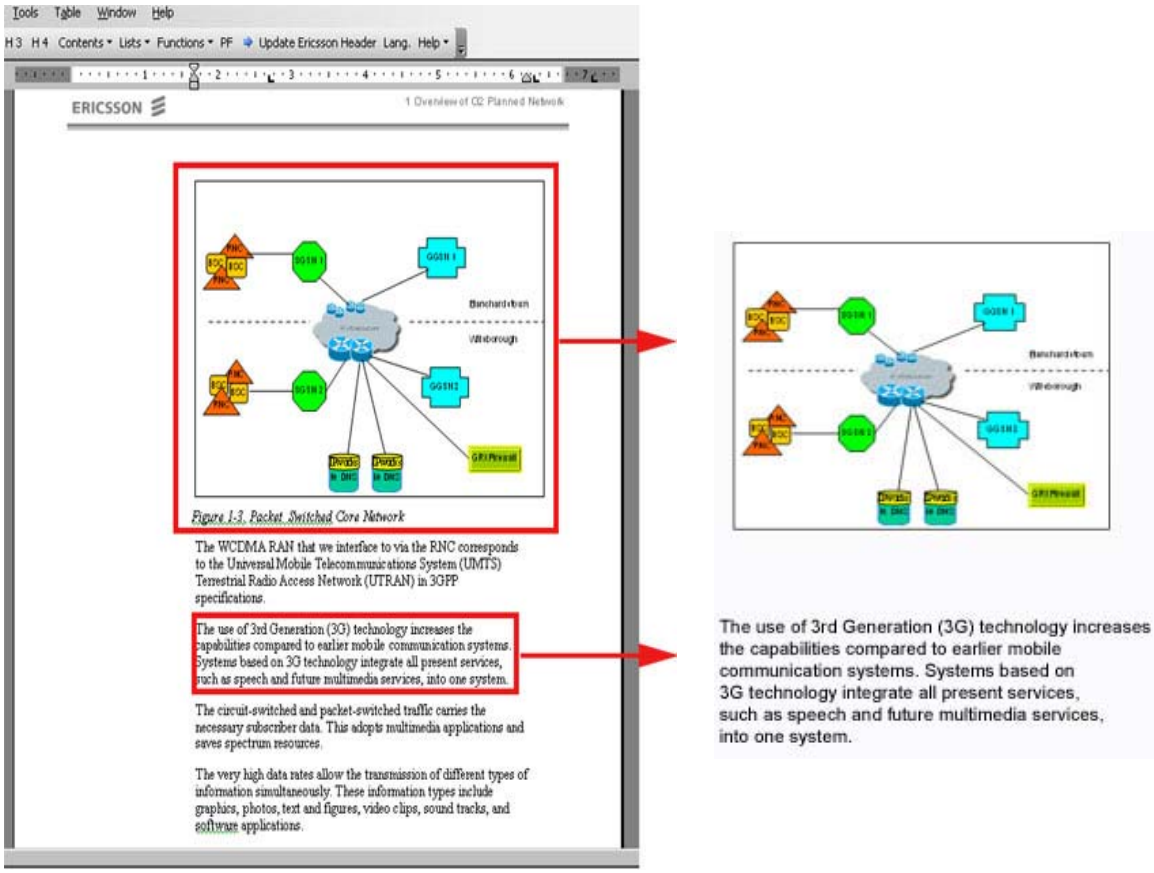
The main advantage of developing in this manner is the reusability of the training content. The way this is achieved is by the correct use of Metadata to tag content.

Metadata is infinitely flexible in terms of what it can describe; the content developer must tag content in a logical and structured way. For example, we may want to build a course consisting of to take the learning objectives from page one of a student textbook, along with the first diagram and the summary text at the end of a chapter. To correctly extract these bits of data, they would need to be individually tagged and pulled out of the system to be packaged by the LCMS.

To illustrate this, let us consider a student textbook used in a classroom delivery. These books can often run to hundreds of pages, with the training spread across several days. For obvious reasons, this is not appropriate for elearning or mobile learning deliveries; we need to take some well-defined subset of this material to deploy to these devices.

This leads to an obvious problem; when you are dealing with hundreds of pages of content, you will not realistically be able to tag everything at that low level. Rather it will be categorized by page or topic and so on.

To overcome this limitation, it is necessary to tag learning objects within their media types, i.e. within an instructor-led course we should mark certain sub-elements as being suitable for mobile learning, or elearning for example. Then we just extract those parts which are relevant for our delivery.



Fig, 7: Extract elements from a ILT textbook

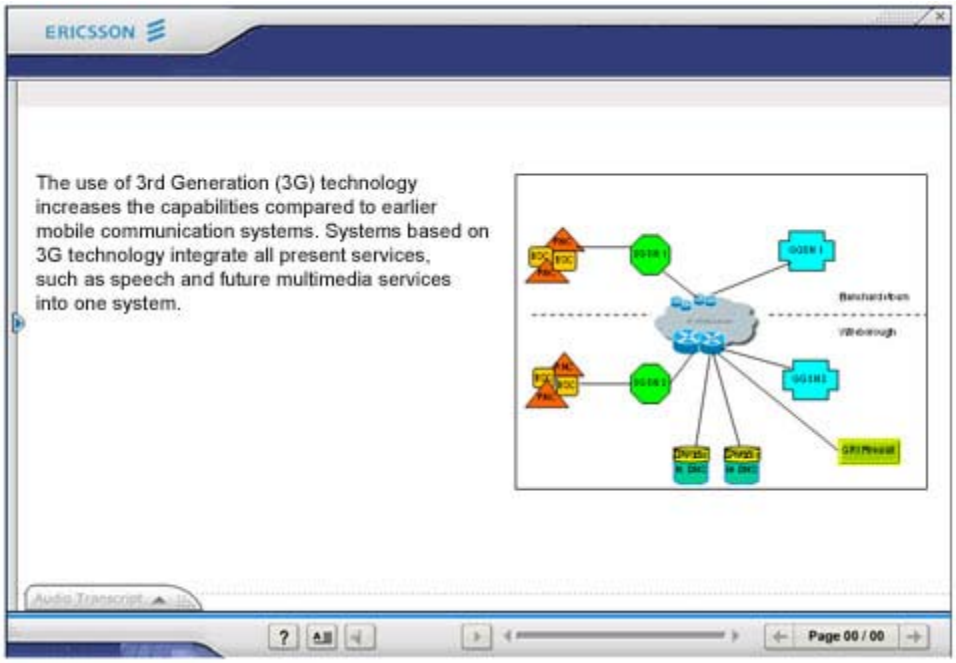


Fig. 8: Insert elements into elearning template

Using this system of tagging, a single ILT course can be "mined" to provide content for an elearning course, a mlearning course and so on. It will still be necessary to write some elements specifically for these delivery types, for example some complex images would need to be scaled down or redesigned altogether to be legible on a mobile device.

In addition, through the development of templates for ILT, eLearning and mLearning, it is now possible to guarantee and deploy the appropriate look and feel to course material regardless for what media it is developed for.

Ubiquity

Ubiquity is now guaranteed at a number of levels. Firstly, now all course developers have access to all resources regardless of for what media they were developed from one repository. As course developers in Ericsson are normally instructors this is even more important as the instructors are not grouped together in one training centre.

The current statistic for mobile phone is 2.5 billion worldwide. Most of these phones support java and html. By developing templates for java and flashlite enabled phones along with blackberries, the widest possible audience can be targeted. Considering Ericsson's customer base, this is very important.

The LMS can deploy customer portals which host the customers' training material, appropriate Ericsson courseware along with material from 3rd Party Suppliers. mLearning can be accessed through these portal through a mobile interface which allows students to download or stream the courseware. The LMS controls who has access to the courseware.

What next

Student Services can be enhanced through the provision of information on course descriptions and prerequisites via the mobile platform. This will enable course administration to become more personal to the student through their mobile device and add value to the training experience

Fully integrated blended learning will become a reality as course deliveries will a true blend of ILT, eLearning and mLearning moving towards a more learner centric environment.

Mobile Broadband will deliver advanced media to the mobile phone such as video and real-time interaction with the LMS. IP Multimedia Subsystem (IMS) will allow the introduction of a suite of services which have the potential to be used for education such as Push to Talk and WeShare. The Push to Talk Application enables real-time communication one-to-one and one-to-many with the press of a button. WeShare is a family of services enabling the sharing of pictures and video while talking. These have the potential to allow mobile tutoring on the fly.

References:

Landers, Paul 2005: Meta Learning: Experiences from the Inclusion of mLearning in a Standards-based and Corporate-wide Learning Content Management Policy mLearn 2005 South Africa.

Ericsson Company Facts www.ericsson.com

Mobile Learning: the Next Generation of Learning
http://learning.ericsson.net/mlearning2/

Incorporation of Mobile Learning into Mainstream Education
www.ericsson.com/mlearning 3

Graham, Katy 2006: Mobile Tutoring and Telecommunications
http://www.ericsson.com/ericsson/corpinfo/programs/resource_documents/eclo_presentation_katy_graham.pdf

Get Ready for .mobi
http://www.ericsson.com/mobilityworld/sub/articles/other_articles/06nov08_dotmobi

Supporting ubiquitous language learning with RFID tags

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Abstract: Ubiquitous computing will help in the organization and mediation of social interactions wherever and whenever these situations might occur. With those technologies, learning environment can be embedded in real daily life. Especially, RFID (Radio Frequency Identification) tags are very useful and important technology to realize ubiquitous computing, because they are able to bridge real objects and information in a virtual world. RFID tags will be embedded in a lot of physical objects in the near future in order to trace products shipping, and so forth. Also, this paper proposes a computer-assisted language learning (CALL) using RFID tags, which is called TANGO (Tag Added learNinG Objects).TANGO detects the objects around the learner using RFID tags, and asks the learner appropriate questions for vocabulary learning in daily life with PDA. There are two different kinds of users of this system: one of them is an overseas University Student in Japan, who wants to learn Japanese Language; the other is a Japanese Student who is interested in English as a second language and plays an important role as a helper for the overseas student. They can share their knowledge through RFID tags and learn language with authentic and tangible objects. In the experiment conducted, the learners were very interested in this system.

Keywords: Computer Supported Ubiquitous Learning, Mobile Learning, Pervasive Learning, Computer Assisted Language Learning, Vocabulary Learning, and RFID tag.

1. INTRODUCTION

Ubiquitous computing (Abowd and Mynatt, 2000) will help organize and mediate social interactions wherever and whenever these situations might occur (Lyytinen and Yoo, 2002). Its evolution has recently been accelerated by improved wireless telecommunications capabilities, open networks, continued increases in computing power, improved battery technology, and the emergence of flexible software architectures. With those technologies, an individual learning environment can be embedded in real everyday life.

The main characteristics of CSUL are shown as follows (Chen et al., 2002; Curtis et al., 2002):

a) Permanency: Learners never lose their work unless it is purposefully deleted. In addition, all the learning processes are recorded continuously everyday.
b) Accessibility: Learners have access to their documents, data, or videos from anywhere. That information is provided based on their requests. Therefore, the learning involved is self-directed.
c) Immediacy: Wherever learners are, they can get any information immediately. Thus, learners can solve problems quickly. Otherwise, the learner can record the questions and look for the answer later.
d) Interactivity: Learners can interact with experts, teachers, or peers in the form of synchronous or asynchronous communication. Hence, the experts are more reachable and the knowledge becomes more available.
e) Situating of instructional activities: The learning could be embedded in our daily life. The problems encountered as well as the knowledge required are all presented in their natural and authentic forms. This helps learners notice the features of problem situations that make particular actions relevant.

Moreover, ubiquitous learning can be Computer Supported Collaborative Learning (CSCL) (O'Malley, 1994) environments that focus on the socio-cognitive process of social knowledge building and sharing.

One of the important ubiquitous computing technologies is RFID (radio frequency identification) tag, which is a rewritable IC memory with non-contact communication facility. This tag is going to replace the barcode. The features of RFID tag are as follows:

(1) Non line-of-sight reading: RFID is not necessary for line-of-sight reading like a bar code. In addition, the range of distance for RFID reader is longer than bar code scan. For example, the

(2) Multiple tag reading: Unlike a bar code reader, RFID unit can read multiple tags at the same time. This feature enables counting the number of objects in a second. That is the reason one of the key applications of RFID is supply-chain management.

(3) Data rewritable: RFID has a memory chip that can be rewritten using an RFID unit. In the mean time, the data of bar code is not changeable.

(4) High durability: Tags are very sturdy from vibrations, contamination (dust and dirt), and abrasion (wear). Hence, tags can be permanently used.

(5) Ease of maintenance: There are two types of RFID tags. One is passive, which is without any battery. The power comes from the reader unit. Therefore, passive tags can be used permanently. The other one is active, which contains batteries and has a longer range than passive ones.

We assume that almost all the products will be attached with RFID tags in the near future and that we will be able to learn at anytime at anyplace from every object by scanning its RFID tag. For example, we can get educational information on goods in stores and also on books in libraries.

This paper proposes TANGO (Tag Added learNinG Objects) System for vocabulary learning. At the beginner’s class of language learning, a label that is written with the name of the object is stuck on the corresponding object in a room in order to remind learners about the word. The idea of this system is that the learner sticks RFID (Radio Frequency Identification) tags on real objects instead of sticky labels, annotate them (e.g., questions and answers), and share them among other learners. The tags bridge authentic objects and their information in the virtual world. TANGO system detects the objects around the learner using RFID tags, and provides the learner with the right information in that context.

2. CSUL: COMPUTER SUPPORTED UBIQUITOUS LEARNING

2.1 What is CSUL?

CSUL (Computer Supported Ubiquitous Learning) is defined as a ubiquitous learning environment that is supported by embedded and invisible computers in everyday life. Figure 1 shows the comparison of four learning environments according to(Lyytinen and Yoo, 2002). The CAL (computer assisted learning) systems using desktop computers are not embedded in the real world, and are difficult to move. Therefore, those systems hardly support learning at anytime and anywhere.

Compared with desktop computer assisted learning, mobile learning is fundamentally about increasing learners' capability to physically move their own learning environment with them. Mobile learning is implemented with lightweight devices such as PDA (Personal Digital Assistant), cellular mobile phones, and so on. Those mobile devices can connect to the Internet with wireless communication technologies, and enable the learning at anytime and anywhere. In this situation, however, computers are not embedded in the learner's surrounding environment, and they cannot seamlessly and flexibly obtain information about the context of his/her learning.

In pervasive learning, computers can obtain information about the context of learning from the learning environment where small devices such as sensors, pads, badges, and so on, are embedded and communicate mutually. Pervasive learning environments can be built either by embedding models of a specific environment into dedicated computers, or by building generic capabilities using computers to inquire, detect, explore, and dynamically build models of the environments. However, this makes availability and usefulness of pervasive learning limited and highly localized.

Finally, ubiquitous learning has integrated high mobility with pervasive learning environments. While the learner is moving with his/her mobile device, the system dynamically supports his/her learning by communicating with embedded computers in the environment. As for the broad definition of ubiquitous learning, both pervasive learning

and mobile learning would be in the category of ubiquitous learning. RFID tags are often used to realize pervasive computing.

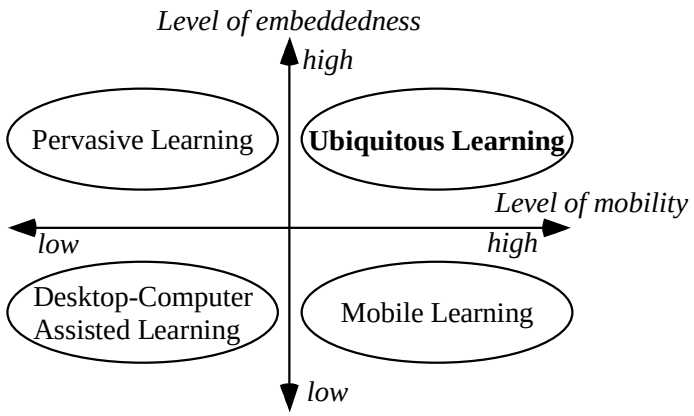

Figure 1: Ubiquitous learning. (Based on (Lyytinen and Yoo, 2002))

2.2 Learning Theories for CSUL

CSUL is advocated by pedagogical theories such as on-demand learning, hands-on or minds-on learning, and authentic learning (Ogata and Yano, 2003; 2004). CSUL system provides learners on-demand information such as advices from teachers or experts at the spot at the precise moment they want to know something. Brown, Collins, and Duguid (1989) define authentic learning as coherent, meaningful, and purposeful activities. When the classroom activities are related to the real world, students receive great academic delights. There are four types of learning to ensure authentic learning: action, situated, incidental, and experimental learning.

Miller and Gildea (1987) worked on vocabulary teaching, and described how children are taught words from dictionary definitions and a few exemplary sentences. They have compared this method with the way vocabulary is normally learned outside school. People generally learn words in the context of ordinary communication. Therefore, we believe that it is very important to support vocabulary learning in everyday life with ubiquitous computing technologies.

3. TANGO

We have developed the prototype system called TANGO, which works on a Toshiba Genio-e with Pocket PC 2002, RFID tag reader/writer (OMRON V720S-HMF01), and wireless LAN (IEEE 802.11b). RFID tag reader/writer is attached on a CF (Compact Flash) card slot of PDA as shown in Figure 2. The tag unit can read and write data into and from RFID tags within 5 cm distance, and it works with a wireless LAN at the same time. The TANGO program has been implemented with Embedded Visual Basic 3.0.

Figure 2: TANGO system.

3.1 Features

The features of TANGO system are:

(1) Vocabulary learning anyplace anytime: We assume that RFID tags will be attached with a lot of products in the future, e.g., food, closes, electronic appliance, and so forth. With those RFID tags, TANGO will enable people to learn vocabulary at anyplace at anytime.

(2) Authentic learning: TANGO uses real-world objects as learning materials and facilitates to link authentic objects to vocabulary. The system allows learners to feel and touch the real objects for better impact and increase in learning effectiveness.

(3) Collaborative learning through objects: TANGO facilitates to share knowledge about real-world objects with questions, answers and comments. This is a kind of collaborative learning because it is a meaning-making process for the objects.

(4) Media integrated learning: TANGO provides multi-media information such as text, voice, and video. The learners are able to confirm the pronunciation of the word object from the text written. Those data is linked to the real objects and enhances the understanding of the knowledge and the communication with other learners.

(5) Personalized learning: According to the learning records, TANGO asks suitable questions to the learner. For example, if the learner correctly answered a question about an object, TANGO will not ask him/her the same question. In addition, each question has different level of difficulties. TANGO provides questions according that level and the learner's level.

(6) Adaptive learning environment: Lerner's record will be created when the system is used. The questions asked will be based on 4 different levels according to the learner's history records.

(7) Game-based learning: TANGO is game-based where points are given when a questions are answered correctly and learners have to move around when using the system differentiates it from normal classroom learning.

3.2 System Configuration

TANGO has the following modules as shown in figure 3:

a) Learner model: This module has the learner's profile such as name, age, gender, occupation, interests, etc, and the comprehensive level of each word or each expression about an object. Before using TANGO, the learner does the examination, and enters the comprehensive level. In addition to this explicit method, TANGO detects learner's comprehension during the system use.

b) Environmental model: This module has the data of objects, rooms and buildings, and the link between objects and expressions in the learning materials database.

c) Educational model: This module manages words and expressions as learning materials. The teacher enters the fundamental expressions for each object. Then, both learners and teacher can add or modify them during system use.

d) Communication tool: This tool provides the users with a BBS (bulletin board system) and a chat tool, and stores their logs into a database.

e) Tag reader/writer: This module reads the ID from an RFID tag attached to an object. Referring to the ID in the object database, the system obtains the name of the object.

f) User interface: This module provides learner with questions and answers.

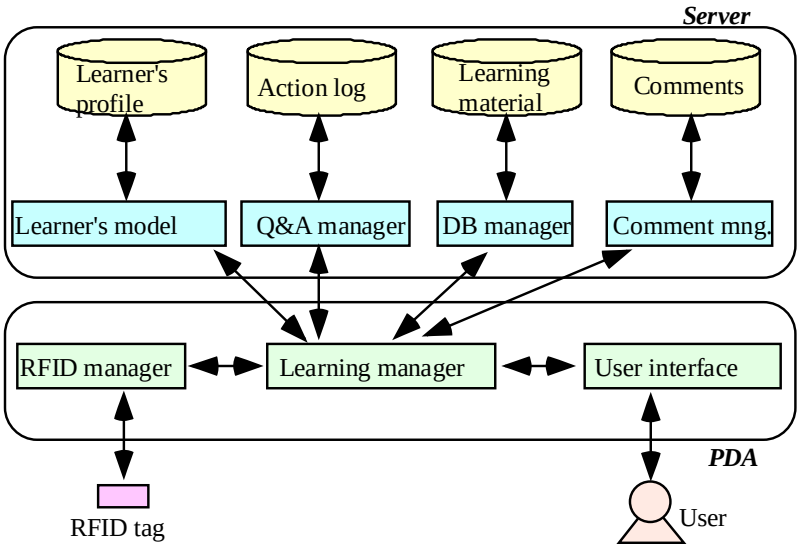

Figure 3: System configuration.

3.3 User Interface

There are 3 mains functions in the system. The interfaces of the learning environment TANGO are shown in Figure 4.

(1) Hint to questions: TANGO system asks the learner a question with voice. The adequate question is selected by scanning the RFID tags around the learner and using the learner model. If the learner cannot understand the question, the learner can listen again by clicking the button. Furthermore, if the learner cannot understand the question, the system can show the text of the question as a hint by clicking the “hint” button. By clicking the “read” button, the system begins to read a

tag. If the learner scans the correct tag, the answer is right. Then, the learner can move to the next question by pushing “next” button.

(2) Creation of new tags: As in Figure 4, anyone can create a new tag to an object. After the object is read into the system, its name, questions related to the object, level of difficulty can be registered into the system. Hence, items in daily life can be used directly as learning materials.

(3) Comments for objects: If the object has a comment, the “comment” button is active. The learner can also add comment by clicking the “add comment” button. The learner has RFID tags, can attach them on objects, and create a new question about the new object as shown in figure 3. In this way, learners can collaboratively learn language by sharing comments and tags.

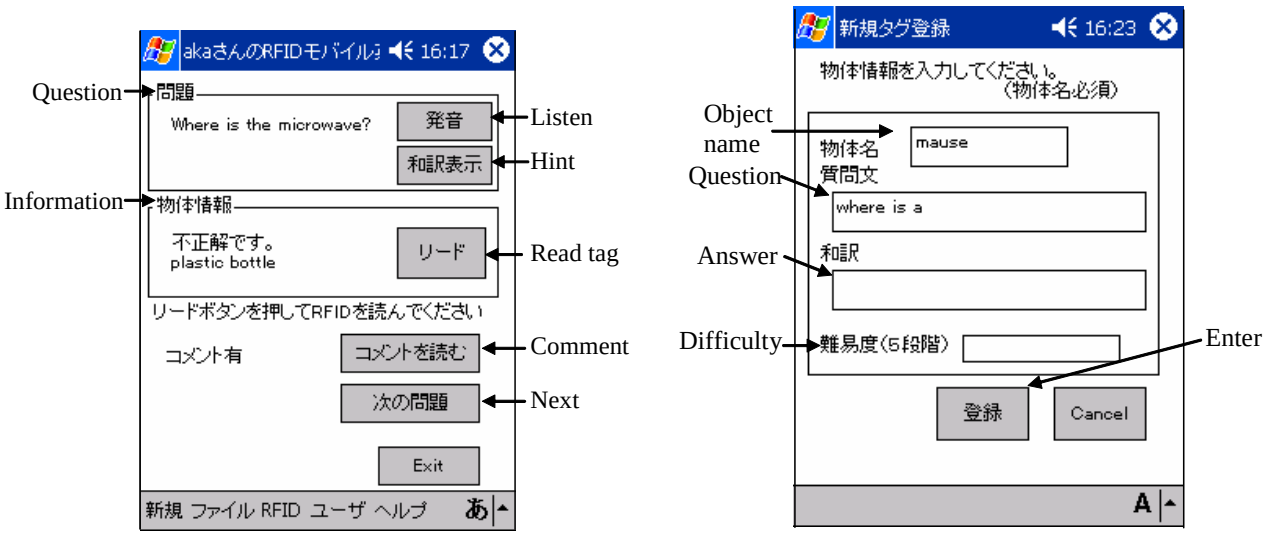

Figure 4: Main window and new-tag window of TANGO.

Figure 5 shows an example of a room where RFID tags were attached to some objects for TANGO. For example, when the learner enters a meeting room, the system asks him/her the question “Where is the remote control of the air conditioner?”. The learner can hear the question again if s/he wants. Moreover, the learner can see the text and hints. If the learner scans the tag labeled on the remote control, the answer is correct. Then the system will ask the learner to put it on the wooden desk. The interaction between the learner and the system goes on in this way.

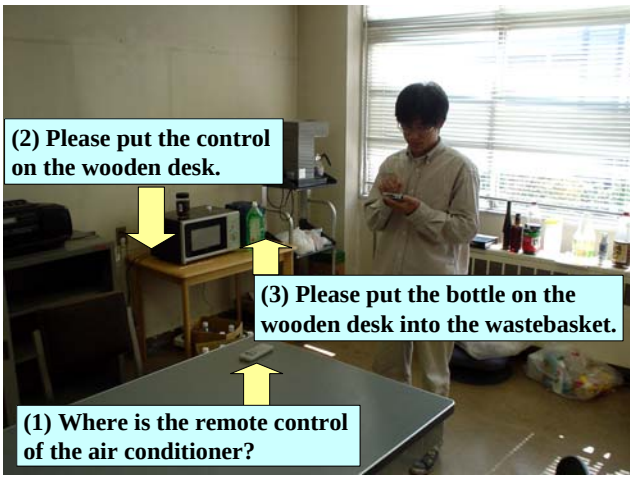

Figure 5: Usage example of TANGO.

4. EXPERIMENTATION

We had eight Japanese student and eight foreign students from our laboratory to evaluate the system. The Japanese students were arranged to use the system to learn English, while the foreign students were arranged to use the system to learn Japanese. The Japanese students consisted of six undergraduates and two masters students with an average age of 22.4 and average English education years of 9.8. As for the foreign students, they are four Dr Course students (one from Mexico, two from China, one from France) and four masters students (two from Mexico, two from China), with an average age of 26.1 and average Japanese education years of 2.2.

4.1 Method of Experimentation

The experiment was conducted over a period of two days. On the first day, the learners were asked to enter a room with 20 objects that are used in daily life such as heated plate, rice cooker, cardboard box, kettle, microwave etc, which they were usually using in their daily life. Twenty questions were prepared as shown in appendix 1. Each learner was given 20 minutes to use the system starting from reading the object's tag, answering the questions and giving comments. Due to unfamiliarity about the usage of PDA, learners were allowed to write their comments on post-it notes and stick it onto the objects (Figure 6). All comments and learning record was registered into the system.

On the second day of the experiment, from the record on the first day, the level of difficulty was determined. The learning was conducted by having the learners input additional comments and suggestions while repeating the same process as the first day.

4.2 Result and Observation

After the experiment, the users were asked to answer a questionnaire where a score between one and five to each of the nine questions is given, with one being the lowest, and five being the highest. Table 1 shows the results of the questionnaire. According to question (1), some of the users felt that the questions that the system asked were difficult. For question (2), the score was average for Japanese students but was more effective among foreign students. There were also comments that the revision that was conducted on the second day helped to increase their level of understanding. According to question (3), the comments were equally positive from both groups. There was also a comment to have the learners use a headphone when listening to the names of the objects for effectiveness. As in question (4), learners were able to identify the objects and its name using the system. According to question (5), the comment function was useful for the Japanese students but not that effective for foreign students due to some misunderstanding in terms of Japanese language related to English. From question (6), we also know that the system was effective to help learners to memorize names of objects. One of the learners commented that with this system, it was easy to understand the terms by corresponding with authentic objects. As for questions (7) and (8), we have comments stating that the system was interesting and

they would like to use the system again. There were also comments that the system was built like a game that makes the learning enjoyable. Some learners commented that they had a feeling of achievement and excitement after using the system.

Besides the questions above, comments and feedback were also obtained from the learners. Some of the positive comments are as follow:

(1) Learning involving real objects was easily understood.

(2) Both the pronunciation and spelling of the object can be learned.

(3) Level of difficulty (pronunciation, text, meaning) created is useful for learning.

(4) Comment function is useful for interaction with other learners and convenient for asking questions.

From the above comments, we can say that the system was useful for learning language in real daily life. If the system is used frequently, the learners can spend lesser time to learn new words in classroom.

Some of the negative comments are as follow:

(1) There were only fixed pattern questions, so it would be better if questions were more application/ practical based.

(2) Only involved objects and names learning.

(3) Unable to see both English and Japanese at the same time.

(4) The answer was given immediately after the second hint was given.

(5) Foreign students have do not know the pronunciation of Kanji in Japanese language.

According to the first comment, the pattern of question is fixed as questions were only on “Where is …” and object names. Since both English and Japanese cannot be used at the same time, the interface will have to be changed. Some modifications will also have to be made to solve the problem in the fourth comment. As for the last comment, modifications will also have to be made when Kanji is used.

Table 1: The results of questionnaires (Ave (1) - for Japanese students; Ave (2)- foreign students).

No.	Questionnaire	Ave.(1)	Ave.(2)
Q1	Were the questions provided by this system difficult?	4.1	4.0
Q2	Do you think the level of difficulty was properly determined?	3.1	4.3
Q3	Was it easy to listen to the names of the objects using the PDA?	4.5	3.9
Q4	Were you able to identify the object and its names easily from the system?	4.4	3.8
Q5	Do you think the comment function is useful?	4.3	3.4
Q6	Do you think this system is useful for language learning?	4.4	4.1
Q7	Do you think that the system was easy to use?	4.5	4.8
Q8	Was the response speed of this system adequate for use?	4.8	4.5
Q9	Was the system interesting to be used?	4.4	4.5
Q10	Do you want to keep using this system?	4.3	4.4

Figure 6: Tango with PostIt (left), Tango without PostIt (right).

5. CONCLUSIONS

This paper described a computer-assisted language learning (CALL) in a ubiquitous computing environment. TANGO system detects the objects around the learner using RFID tags, and provides the learner with the educational information. In the experiment, the learner played the game of TANGO, and was very interested in this system. The implementation for TANGO is hoped to be spread not only to learn English or Japanese but also other languages such as Chinese or Spanish. The feedback from the evaluation will be used to improve the current system for ease of usability. RFID tag will be a very important element for the realization of a ubiquitous society especially with the advancement of memory storage, wireless technology and potential of programming languages and techniques. The TANGO system developed has utilized RFID because the future of RFID is unlimited and its usage will be embedded in various technologies and environments and is vital as a tool to aid in education and learning.

ACKNOWLEDGEMENT

This work was partly supported by the Grant-in-Aid for Scientific Research No.15700516 from the Ministry of Education, Science, Sports and Culture in Japan.

REFERENCES

Abowd, G.D., and Mynatt, E.D.: Charting Past, Present, and Future Research in Ubiquitous Computing, ACM Transaction on Computer-Human Interaction, Vol.7, No.1, pp.29-58, 2000.

Brown, J. S., Collins, A., and Duguid, P.: Situated Cognition and the Culture of Learning. Educational Researcher, (Jan.-Feb.), pp.32-42, 1989.

Chen, Y.S., Kao, T.C., Sheu, J.P., and Chiang, C.Y.: A Mobile Scaffolding-Aid-Based Bird -Watching Learning System, Proceedings of IEEE International Workshop on Wireless

and Mobile Technologies in Education (WMTE'02), pp.15-22, IEEE Computer Society Press, 2002.

Curtis, M., Luchini, K., Bobrowsky, W., Quintana, C., and Soloway, E.: Handheld Use in K-12: A Descriptive Account, Proceedings of IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE'02), pp.23-30, IEEE Computer Society Press, 2002.

Lyytinen, K. and Yoo, Y.: Issues and Challenges in Ubiquitous Computing, Communications of ACM, Vol.45, No.12, pp.63-65, 2002.

Miller, G. A., and Gildea, P.M.: How children learn words. Scientific American, No.257, pp.94–99, 1987.

Ogata, H., and Yano, Y.: How Ubiquitous Computing can Support Language Learning, Proc. of KEST 2003, pp.1-6, 2003.

Ogata, H., and Yano, Y.: Supporting Knowledge Awareness for a Ubiquitous CSCL, Proc. of E-Learn 2003, pp.2362-2369, 2003.

Ogata, H., and Yano, Y: Knowledge Awareness Map for Computer-Supported Ubiquitous Language-Learning, Proc. of IEEE WMTE2004, Taiwan, 2004.

Ogata, H., and Yano, Y: Context-Aware Support for Computer-Supported Ubiquitous Learning, Proc. of IEEE WMTE2004, Taiwan, 2004.

O’Malley, C.: Computer supported collaborative learning, NATO ASI Series, F: Computer & Systems Sciences, Vol.128, 1994.

Appendix 1:

Questions that were asked in the experimentation are follows:

1. Where is the cardboard box for bottles?
2. Where is the kettle made from metal?
3. Where is the microwave?
4. Where is the orange color shelf?
5. Where is the wet wipe?
6. Where is the bamboo chair?
7. Where is the remote control of the air conditioner?
8. Where is the black color CD boom box?
9. Where is the ladle?
10. Where is the lid for the pan?
11. Where is the crab-shaped chopping board?
12. Where is the wash stand (sink)?
13. Where is the copier?
14. Where is the heated plate?
15. Where is the plastic bottle of Chinese tea?
16. Where is the rice cooker?
17. Where is the barbeque sauce?
18. Where is the mirror?
19. Where is the wooden desk?
20. Where is the fabric chair?

Using Mobile Learning to Enhance the Quality of Nursing Practice Education

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Abstract

The purpose of this paper is to review the research literature pertaining to the use of mobile devices in Nursing Education and assess the potential of mobile learning (m-learning) for Nursing practice education experiences in rural higher education settings. While there are a number of definitions of m-learning, we accept that advanced by Koole's (2005) FRAME model, which describes it as a process resulting from the convergence of mobile technologies, human learning capacities, and social interaction, and use it as a framework to organize this literature. We also report on the initial stages of a project to integrate mobile learning into the Bachelor of Science Nursing curriculum in a Western Canadian college program. Third year students and instructors will be using mobile devices with wireless capability and selected software, such as Nursing decision-making and drug reference programs, during their practice in a community-based course. Course learning activities will be developed to test the use of these devices to support students' access to resources at the point-of-care, to connect to web-based resources, and for peer-to-peer communication. A formative evaluation is planned to determine if the use of mobile learning can be implemented and sustained in an independent learning setting, to assess the appeal of mobile learning use in a real life instructional setting to the target audience, and to judge the effectiveness of the program to enhance reflective practice in Nursing students.

Key Words: Nursing education, practice education, mobile learning, m-learning, FRAME Model

Mobile Learning to Enhance the Quality of Nursing Practice Education

The Promise of Mobile Learning

Wagner (2005) has claimed that the evidence of the widespread adoption in North American society of mobile wireless technology such as cell phones, personal digital assistants (PDAs), laptop computers, and MP3 players, is irrefutable. Researchers (e.g., Hill & Roldan, 2005; Wagner, 2005) refer to current mobile (especially wireless) technology as third generation (3G). By affording the transfer of voice and non-voice data, 3G wireless technologies provide an unprecedented opportunity for inexpensive and beneficial computing power for learners.

Wagner (2005) asks why, with the continuing expansion of wireless networks and improved capacity portable electronic devices, this mobility should not apply to learning. Keegan (2002, 2005) agrees, declaring that the future of distance education is wireless and noting that there has never been a technology that has penetrated the world with the depth and rapidity of mobile telephony. He claims that the challenge for distance educators is to accept this fact and to now develop pedagogical environments for mobile devices.

Is e-learning truly giving way to mobile learning (m-learning) or is the latter merely a subset of the first? What exactly do we mean by m-learning and what does it allow educators to do differently than other forms of teaching and learning? Keegan (2005) defined the term simply as the provision of education and training on PDAs/palmtops/handhelds, smart phones and mobile phones. Trifonova and Ronchetti (2003) agreed, noting that m-learning is often defined as e-learning carried out by means of mobile computational devices and point out that this refers mainly to PDAs and digital cell phones. M-learning could “employ any device that is small, autonomous and unobtrusive enough to accompany us in every moment of our everyday life” (p. 32).

Nyiri (2002) also argues that m-learning is not simply e-learning revisited. He claims that mobile devices will soon become the dominant means of access to the Internet. M-learning will allow learners and instructors to focus on knowledge that is location and situation dependent and interdisciplinary in nature, knowledge arising from practical tasks, and will afford mobile person-to-person communication and reflection in action. In addition, Hill and Roldan (2005) claim that mobile learning is well suited to a Constructivist view of learning which shifts instructor and student roles to a learner-centric model and stresses that knowledge is built from an interplay of action and reflection. Emerging mobile technologies will permit threaded discussions to better emulate face-to-face discussions by delivering discourse in real time to wherever participants are. Similarly, Kukulska-Hulme and Traxler (2005) view the most significant attributes of mobile technologies as their ability to support learning that is more situated, experiential and contextualized within specific domains and to support the creation and use of more up-to-date and authentic content.

Mobile Learning in Health Care Education

The education of health care professionals in the context of a rapidly changing health care system is a prime example of how the mobility of learners within a variety of real life learning environments has posed increasing challenges and where mobile technologies has the potential to support and enhance teaching and learning. The high acuity and pace of practice in institutional environments, combined with an explosion of knowledge and technology, increasingly requires practitioners to access and process clinical data efficiently by drawing on current resources to support safe care and evidence-informed practice at the point of care. Moreover, the shift of client care to the community requires that the education of health professionals take place increasingly in this more autonomous and diverse practice environment where resources are not

readily accessible, where client acuity is increasing, and where more traditional methods of directly observing and working with students are not as feasible. These shifts in practice, along with more limited education and practice resources to support students' practice, raise concern for the quality of their education and the safety of their practice. This is particularly significant for rural practice education where resources are limited and geography poses additional challenges. Addressing these "new age" challenges requires "new age" approaches and tools to support the teaching and learning of health professionals.

The purpose of this paper is to explore the potential of m-learning for Nursing practice education. We will use the FRAME model (Koole, 2005; Koole & Ally, 2006) to review the literature on m-learning in health care, and more specifically, in Nursing practice education. We will conclude with a discussion of how challenges in Nursing education can be addressed with the use of mobile technologies and discuss a pilot project to begin examining this question.

The FRAME Model

Koole (2005; Koole & Ally, 2006) has developed the FRAME model for m-learning and describes it as a process resulting from the convergence of mobile technologies, human learning capacities, and social interaction. The FRAME model is represented as an intersecting set of three circles (See Figure 1) representing device usability, learner, and social aspects of learning.

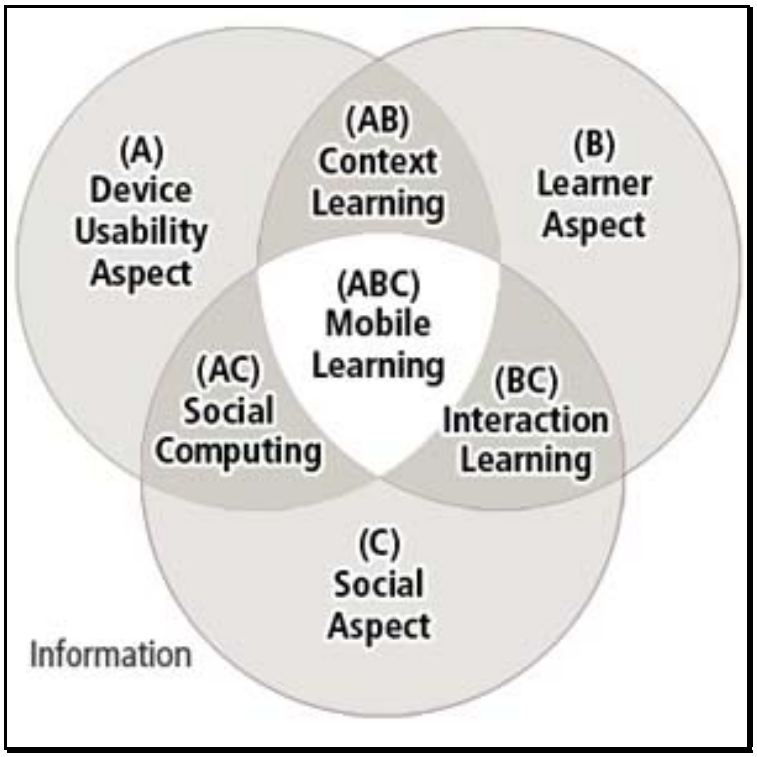

Figure 1. Koole's FRAME Model (reproduced with permission)

Device Usability Aspect

This describes the physical, technical, and functional components of mobile devices, the medium through which mobile learners and mobile community members interact. This interface is both enabled and constrained by the hardware and software design of the devices and can have a significant impact on the physical and psychological comfort levels of the users.

The Learner Aspect

This refers to the individual learner's cognitive abilities, memory, and prior knowledge and those situations and tasks in which a learner needs to succeed. It encompasses the wide range of theories of how learners learn (e.g., Driscoll, 2005; Mayes & de Freitas, 2004) and explains how mobile learning offers an extended environment where learners can interact within their physical and social environments.

The Social Aspect

This aspect refers to the processes of social interaction and cooperation and conveys an underlying thread of social constructivist philosophy. The way in which individuals exchange information affects how groups of people develop knowledge and sustain cultural practices. Communication is seen as a cooperative activity, one accomplished through culturally meaningful signs and symbols. The social aspect has an important role in both the interaction learning (BC) intersection and the mobile-learning process (ABC) itself.

The Secondary Intersections

These contain attributes that belong to each set of overlapping aspects. Those features located inside the secondary intersections of context learning (AB) and social computing (AC) describe the affordances of true mobile devices; that is, what the devices permit in terms of flexibility of learning, information access, psychological comfort, connectivity, and collaboration among learners. The secondary intersection labeled interaction learning (BC) refers to instructional techniques and learning theories.

Context learning (AB). This intersection relates the characteristics of mobile devices to cognitive tasks and to the effective manipulation and storage of information. Highly portable devices permit learners to move with their mobile tools to more relevant or more comfortable locations and can affect the user's sense of psychological comfort and satisfaction by reducing cognitive load and increasing access to information.

The social computing intersection (AC). This aspect describes how mobile devices enable users to communicate with each other and to gain access to other networked systems and information. When people are able to exchange relevant information at appropriate times, they

can participate in collaborative situations that are normally difficult at a distance. This ability to interact is a significant characteristic of learning according to social constructivist philosophy.

Interaction learning (BC). This intersection (BC) focuses on social interaction. Some constructivists hold that learners indirectly negotiate the meaning of materials by comparing their interpretation with that of the author, while others contend that learners interact and *negotiate* meaning with other individuals directly (Smith & Ragan, 2005). The interaction learning intersection is balanced between these viewpoints. Participation in learning communities and cognitive apprenticeships can provide socially based learning environments in which learners can acquire information and negotiate meaning.

The Mobile Learning Process (ABC). All three aspects overlap at the primary intersection (ABC), which represents a convergence of all three aspects and defines the m-learning process. As such, m-learning can afford learners access to a variety of human, system, and data resources, as well as to assist them to assess and select relevant information and redefine their goals (Koole, 2005). M-learning is, however, also constrained by the mobile device hardware and software configurations and dependent upon adjustments in teaching and learning strategies.

The Use of Mobile Learning in Health Care and Nursing: Review of the Literature

While there is evidence of the use of PDAs in field work in education and science (refs), health care practitioners have shown themselves to be early adopters of the technology because of its logical fit with clinical practice.

Experiences with Mobile Learning in Health Care Generally

According to Cahoon, in 2002 the use of handheld devices by clinicians had “exploded” (p. 1) and “clinicians [were] flocking to PDAs (Personal Digital Assistants) and they are pulling

their institutions with them" (p.3). Physicians or physicians in training appear to have been early adopters of this technology. The first noted function was access to pharmacological resources. George and Davidson (2005) state that, in 2003, one-third of Canadian physicians were using hand held devices in their practice. The appeal is size. As Tooey (2003) notes, it can be put in the pocket like a prescription pad and is therefore is not intimidating to the patient. It substitutes for carrying around reference books, laptop computers, calculators, etc.

Much of the medical use of PDA research relates to pharmacology. In a survey of 3,000 online participants (Rothschild, Lee, Bae & Bates, 2002), 78.9% reported that the use of the PDA software, ePocrates Rx, increased their drug knowledge, with 72.3 % reporting at least one positive decision made weekly based on the use of the program. It is important to note, however, that the study was affiliated with ePocrates. Further studies are necessary. Carroll and Christakis (2004) have also noted the potential for industry bias in studies that have been conducted.

The National Coordinating Council Medical Error Reporting Program (as cited in Galt, Rule, Houghton, Young, & Remington, 2005) reports that the most frequent types of medication errors are most likely due to insufficient information at the point-of-care. Galt et al. (2005) compared the potential for drug software to guarantee medication safety with respect to specific, accurate, complete information at the point-of-care. Three software programs met quality indicators for drug information. It was determined that no one program could provide all the information needed. Respondents of a survey of paediatricians regarding use and attitudes of PDAs revealed that, on a Likert scale of 1-5, 4.2 was the mean for those PDA users who believed PDAs had the potential to prevent medication errors. The mean for non-users was 3.8.

Second in number to those investigating the pharmacological use of PDAs are studies examining use of PDAs to connect to online resources. Fontelo, Ackerman, Kim and Locatis

(2003) studied the use of handheld devices by physicians to access MEDLINE and other knowledge sources via wireless connection. Participants were able to access live web casts from two conferences as well as to access PubMed and the http://www.ClinicalTrials.gov website to search for articles. Initial reports found handheld devices to be a “powerful resource in the practice of evidence-based medicine” (p. 147).

One challenge to the use of PDAs in the clinical setting is ensuring security of information. Cacace, Cinque, Crudele, Iannello and Venditto (2004) report on an internal hospital information system project which provided Medicine, Nursing and Dietetics students with hand held devices using private software through an internal WAN. They conclude that the project was valuable in:

> "improving the accessibility to the information system at different levels (students, nurses, physicians) through mobile technologies; improve teaching and learning in the wards through a faster access to clinical data; designing new interfaces for small devices for collecting and examining data at the bedside; a deeper comprehension of security issues; analysis of geographical mobility needs; performance evaluation" (p.4).

Smordal and Gregory's (2003) study of the use of PDAs by medical students was much more specific in relation to some of the technical barriers. They reported that few websites were adapted for PDA screen size, which limited their utility for browsing and interaction. They also note that the transmission of web pages using a GSM (cell phone transmission) connection to PDAs is slow and the cutting and pasting of materials from one application to another was limited. As such, they conclude that these barriers limited the usefulness of PDA's as communication devices and are related to the complexities of infrastructure.

As well, there are studies (e.g., Barrett, Strayer & Schubart, 2004), which report on surveys and interviews of medical residents, to qualitatively understand what they like and dislike and how they used PDAs. The major finding was that most residents used PDAs on a daily basis but that security and HIPAA compliance issues need to be addressed.

Experiences with Mobile Learning in Nursing

Nursing is following suit and we are seeing an increasing emphasis on the use of PDAs by nurses and nursing students in clinical settings. Rosenthal (2003) outlines a number of functions identified by nurses using PDAs: address book, "to do" lists, date book, memo pad, expense tracking, "find" functions, medical references, diagnostic tools, patient student and staff management programs, clinical guidelines, medical dictionaries and lab values . She categorizes these as tools that enhance productivity, promote risk management/error reduction, and through their rapid access to critical information lead to stress reduction.

Cahoon (2002) groups the functions into five categories: clinical services, calculators, data collection, medical record system and content tools. Newbold (2003) notes that if the PDA is also a wireless device, the uses increase in both number and complexity. She lists potential applications such as: interdisciplinary consultations, electronic ordering and test results, patient histories, progress notes and assessments, references, protocols, and prescription information. Increased PDA wireless capacity to include phone and camera capabilities permits rapid chart access, improved workflow, increased time for patients, cost savings, enhanced productivity and, therefore, boosts professional satisfaction.

The utilization of PDAs in nursing practice has not been confined to acute care settings. George and Davidson (2005) note that in both long term care and community based sites, nurses are utilizing the new technology to improve their practices. Community based nurses are using

PDAs to provide patient teaching information and to track patient progress. In describing initial trials with the Nightingale Tracker, Thomas, Feldman and Coppola (2001) stated:

> "each visit can be instantaneously recorded and once sent to the server, can be retrieved back at the office within minutes if necessary. The ability to navigate the Web, show Web sites to the patients, and access teaching plans allows for individualization of care instead of waiting a week or longer for the next visit. Electronically inputting the data immediately and efficiently will decrease longhand recording and free the community nurses to do what they do best - care for clients!" (p.3)

Several authors have outlined benefits and barriers to PDA use. In the literature review for her master's thesis, Davenport (2004) identified 38 barriers and 68 benefits to PDA use. Through a process of mind mapping, she produced six themes in each category, based on a survey completed by nurses. Ranking them in priority she found the following benefits and barriers. The benefits were: a) quick access to current drug database and nursing reference books (highest ranking); b) the ability to manage patients and procedure information, bedside data entry, and data collection for research and teaching (tied for the 2nd, 3rd,and 4th rankings); c) patient health management (ranked 5th); and d) improved team communication (ranked 6th).

Davenport also found the following barriers, ranked by priority: a) the risks of storing confidential patient information; b) the cost of PDAs and ease of loss or damage; c) not enough research on PDA use in nursing; d) difficult to read, e) slow data entry; and f) difficult to understand. These barriers were rated as modest to moderate. In her study of second-degree students entering an accelerated baccalaureate nursing degree, Miller et al. (2005) utilized pre-post and comparative group design to investigate students' use of Palm Operating Software (OS) PDAs. The only risks identified were related to expense of PDA, software and staff support.

In her summary, Davenport (2004) states that "health care organizations have the responsibility to provide the safest possible patient care and that includes the use of the most current, most easily accessed information" [p. 5]. This is supported for nursing education by Altman and Brady (2005):

> "one of the primary goals of nursing education is to provide students with skills to adapt to a rapidly changing healthcare environment. Ours is a world of technology and information management. Hence, one of the essential keys in educating students is teaching them how to be efficient and accurate information gatherers, and apply this process in providing optimal patient care" (p.9).

Experiences with Mobile Learning in Nursing Education

Lehman (2003) identified challenges faced by nursing instructors in the practice setting. She reported using PDAs to keep record of student assignments, checklists for completing physical assessments and as a source of point-of-care reference (drug software). This eliminates the need for carrying hardcopy drug references. Lehman also used the PDA to document student progress on-the-spot. It was reported that previous studies found electronic data to be more accurate than paper documentation.

Miller et al. (2005) conducted a pre-post and comparative study to identify nursing "students' information seeking behaviours and the effectiveness and cost of innovation strategies associated with incorporation of PDAs into students' clinical practice" (p.19). They concur that "through the incorporation of PDAs in undergraduate clinical courses, it is anticipated that the value and skill of seeking current information will become a routine that nursing students take into their professional practice"(p.19).

Due to limitations of the study, authors note that differences among the two groups in seeking information cannot be attributed to PDA use. It was however determined that students utilizing PDAs had increasing numbers of questions when in the practice setting, as well as a greater recognition of the need to use current resources.

Goldsworthy, Lawrence and Goodman (2006) examined the relationships between the use of personal digital assistants, self-efficacy and the preparation for medication administration. Thirty six second-year baccalaureate nursing students were randomly assigned to either a PDA or control group. The authors reported that the PDA group showed a significant increase in self-efficacy.

Stroud, Erkel, and Smith (2005) reported on the patterns of use and demographics of users within nurse practitioner (NP) programs. A 20 item questionnaire was sent to students and faculty in 150 organizations across the US. The 227 returned questionnaires represented 27% of the sample. A high percentage, 67% of those returning the questionnaire, used PDAs, generally to "support clinical decision-making" (p.67). The list of uses and frequency cited is reported in Table 1.

In June 2006, a Western Canadian University's Centre for Nursing and Health Studies polled their nurse practitioner students on PDA use. Two anonymous surveys were built into the course platform,WebCT, "I use a PDA" and "I don't use a PDA", and an email sent to all listed on the program student alias list invited students to choose the appropriate survey and complete it. One hundred and fifty students responded within 5 days; 64 (42.6%) in the "use" category and 86 (57.3%) in the "do not use" category (Author, 2006). The results are reported in Table 1.

[Insert Table 1 about here]

Student NPs in the Author (2006) sample also had a wide range of perceptions of reasons to recommend PDAs to other NPs and of the barriers to use. These are reported in Table 2.

[Insert Table 2 about here]

The relationship between FRAME model and research on mobile learning in Nursing

Effective mobile learning is defined by the convergence of the device usability, learner, and social aspects to extend their impact beyond their natural boundaries. Mobile learning affords enhanced collaboration among learners, ready access to information, and a deeper contextualization of learning. Mobile learning can help learners gain immediate and ongoing access to information, peers, and experts who can help them determine the value of information found on both the Internet and in their real-world environments (Koole & Ally, 2006). The relationship between the FRAME Model and the themes reported in the research literature are shown in Table 3.

[Insert Table 3 about here.]

A number of research articles relating to healthcare professionals use as PDAs focus on the aspect of device usability (e.g., Cahoon, 2002; Newbolt, 2003; Rosenthal, 2003). When selecting a device, all researchers will concern themselves with physical and psychological comfort of the user. Research and development in this area by manufacturers will continue with user input. Healthcare professionals have traditionally carried small booklets and index cards in their pockets, so they are natural early adopters for PDAs as content providers. Students are always in the market for the latest and best, so new innovation permeates the field.

The learner aspect of Koole's FRAME theory is demonstrated by the healthcare professional/students' experience and interaction within the clinical setting, which includes the clients/patients, the facility or home and multiple caregivers. Besides reference content, many

existing tasks such as sending pharmacy and laboratory requisitions have translated to PDAs easily. The ongoing recording of patient information is also facilitated. These activities are documented in the research (Cacace et al., 2006; Thomas et al., 2001). Less, however, is reported on the psychological comfort of the user when carrying out this research using mobile devices. [The Western Canadian] University Nurse Practitioner students used the term “security blanket” and “safer than memory” in their list of reasons to recommend the use of PDAs (Author, 2006). The use of PDAs in medication error research also exemplifies this comfort (Rothschild et al., 2002; Galt et al., 2002). Conversely, a few students felt that a PDA might come between them and the patient/client and lead to the loss of personal touch (Author, 2006).

The Social Computing Intersection is the least explored component. LANs and free or inexpensive wireless connectivity address the physical part of this intersection. Students in both Stroud et al. (2005) and Author (2006) mention email as the only interactional use of the PDAs. We are now interested in the use of PDAs to help to form a learning community. The connectivity potential of these devices for practice and teaching/learning has not been fully explored.

We conclude from this review, that there has been little research on interactional use of PDAs by health care professionals. As well, further research and exploration is required relating to confidentiality and security of data with PDA use. The final issue, cost, will most likely decrease with increased demand and increased wireless capacity.

The Use of Mobile Technologies to Address Challenges in Nursing Practice Education

Changes in health care delivery has impacted nursing practice education and as a result created ideal conditions for the implementation of m-learning approaches. More specifically,

care is moving to the community where client complexity and acuity is increasing and where up-to-date information at the point-of-care is critically needed to support practice. This means that care delivery requires physical mobility throughout the community which does not lend itself to more traditional direct teaching supervision models. As a result, instructors typically supervise twelve to sixteen students at a distance and they must rely on instructional and evaluation that are retrospective in nature. In other words, the instructor is removed from instruction at the point of care and the real-time responsibility for instruction falls on preceptors, or field guides who are often non-nurses, and whose focus is necessarily on service delivery rather than pedagogy. As a result, students are often relegated to an observational role which limits opportunities for their professional development.

As outlined in the FRAME model (Koole, 2005; Koole & Ally, 2006), the social environment is an essential component to the construction of knowledge by the learner. Mobile learning that provides opportunities for connectivity and interaction has the potential to provide the learner with a meaningful learning environment, one in which the learning is situated in a real life context. Timely and rapid access to practice resources (e.g., instructor, peers, information / reference materials, agency information such as policy manuals, agency contact), would better support teaching and learning, particularly when practice takes place in the community where the instructor is further removed from the point of care and where opportunities for student to student interactions are more limited. Not only is connectivity important for learning but it would also support students' safety to practice because of increased decisional resources and guidance. Students' connectedness with instructors at the point of care would also foster support of preceptors/field guides/unit staff and assist students to make more appropriate use of clinicians as clinical experts. This may in turn enhance preceptor's

willingness to work with students as the responsibility for supervising students is shared more equally thereby increasing practice placement capacity. As such, the use of mobile technologies not only has the potential to impact the teaching learning environment for faculty and students but it extends the community of learners to the larger practice context and culture.

The requirement to provide theory and evidence-informed care to clients (College of Registered Nurses Association of British Columbia [CRNBC], 2000) is also challenging in the context of more isolated care in the community and of a rapidly expanding body of knowledge. Access to current knowledge can be problematic for students in the practice setting because of limited access to text resources, computers and connectivity to the internet and library data bases. Although clinicians often have access to such resources, student access has been a problem because of security concerns and minimal infrastructure and support for students in agencies. Moreover, access to resources to support theory and evidenced informed client care becomes even more challenging for students when access is further removed from the point of care.

In keeping with Koole's (2005) FRAME model, access to and usability of mobile learning devices is critical to supporting the context of learning and learning interactions. Carefully planned selection of hardware, software (such as decision-making and drug reference programs), and connectivity options that meets the learner's cognitive, physical and psychological needs in the context of their learning environment is critical in supporting theory and evidenced-informed practice. This is also important in supporting students' safety to practice.

Finally, limited access to technological infrastructures in the community and limits the development of the students' competencies in using informatics in their practice (CRNBC, 2000). Increasingly, practice environments require electronic data retrieval and entry.

Technologies are becoming more mobile and tailored to specific practice environments therefore requiring professionals to develop comfort with a variety of technologies and to make use of transferable informatics knowledge and skills. It is challenging for nurse educators to support students in this development prior to graduation because when access by students and faculty to technologies in the practice setting are limited as outlined above. The integration of m-learning technologies in nursing education programs and more specifically in the practice courses would not only assist the development of informatics competencies but would also ease the graduates' transition to their professional practice in a more seamless manner. The use of m-learning technologies also has the potential to support students in their leadership development as they interact more equally with the interdisciplinary team by using informatics, information management, theory and evidence-informed practice. As such, the development of informatics competencies requires attention to social computing, the context of learning and interactions between learning communities as outlined in the FRAME model (Koole, 2005; Koole & Ally, 2006).

Together, the resulting educational challenges to changes in health care delivery have created an ideal environment for mobile technologies that provide resources for students at the point of care and which enable instruction to be re-introduced in real time.

Next Steps: The Pilot Project

Guided by the FRAME model (Koole, 2005; Koole & Ally, 2006) we have designed a pilot project which will help us to begin to address the address gaps in the literature and challenges in nursing practice education outlined above. Third year Baccalaureate of Science in Nursing students and instructors in a community-based practice course will use pocket computers in the form of PDAs with selected installed software (e.g. nursing decision-making and drug reference

programs) and GSM / GPRS wireless capability in the context of a pedagogical environment and learning strategies for mobile devices. Users will be oriented to these devices and course learning activities will be adapted and developed to test the potential use of mobile devices to support students' access to resources at the point of care, and to test these devices' connectivity potential to web-based resources, instructional supports (i.e., electronic communication among instructors/students/field guides/preceptors), and peer-to-peer learning.

Many authors have reflected on what we can expect the impact of emerging mobile technology to be on learning. When considering the role of any new technology in the teaching and learning process, it is important to exercise extreme caution in attributing direct causal relations. Comparison research on media effectiveness has led to decades of no significance difference results (Clark, 1983, 1994; Russell, 1999) and, while the debate continues (Clark, 1994; Kosma, 1994), it is perhaps more appropriate to consider what new capabilities m-learning can bring to the teaching-learning equation.

As such, this project will situate these technologies within the real life teaching and learning environment of practice and will conduct a formative evaluation based on the FRAME model (Koole, 2005) to assess whether or not the use of mobile learning can be implemented and sustained in an independent learning setting, to assess how the use of mobile learning fits the instructional environment and curriculum design, to assess the appeal of the use mobile learning to the target audience in a real life instructional setting, to assess the instructional design of various learning activities designed to make use of the mobile devices, and to assess the effectiveness of the program to enhance reflective practice in Nursing students.

References

Altman, T. K., & Brady, D. (2005). PDAs bring information competence to the point-of-care. *International Journal of Nursing Education Scholarship, 2*(1). Retrieved September 26, 2005, from http://www.bepress.com/ijnes/vol2/iss1/art10

Barrett, J.R., Strayer, S.M., & Shubart, J.R. (2004). Assessing medical residents' usage and perceived needs for personal digital assistants [Electronic version]. *International Journal of Medical Informatics, (73)*, 25-34.

Cacace, F., Cinque, M., Crudele, M., Iannello, G., & Venditti, M. (2004). *The impact of innovation in medical and nursing training: A hospital information system for students accessible through mobile devices.* Proceedings of mLearn 2004, the 3rd World Conference on Mobile Learning. Rome, Italy.

Cahoon, J. (2002, April). Handhelds in healthcare: Benefits of content at the point of care. *Advances in Clinical Knowledge Management*, *5*. Retrieved Sept 16, 2005 from http://www.openclinical.org/docs/ext/workshops/ackm5/absCahoon.pdf

Clark, R.E. (1983). Reconsidering research on learning from media. *Review of Educational Research, 53*, 445 – 459.

Clark, R.E. (1994). Media will never influence learning. *Educational Technology, Research and Development*, *42*(2), 21-29.

Davenport, C. (2004). *Analysis of PDAs in Nursing: Benefits and barriers.* Retrieved Sept 16, 2005 from www.pdacortex.com/Analysis_PDAs_Nursing.htm

Driscoll, M.P. (2005). *Psychology of learning for instruction (3rd Ed.)*. Boston, MA: Pearson – Allyn and Bacon.

Fontelo, P., Ackerman, M., Kim, G., & Locatis, C. (2003). The PDA as a portal to knowledge sources in a wireless setting [Electronic version]. *Telemedicine Journal and e-Health, 9*(2), 141-147.

Galt, K.A., Rich, E.C., Young, W.W., Markert, R.J., Barr, C., Houghton, B, et al. (2002). Impact of hand-held technologies on medication errors in primary care [Electronic version]. *Topics in Health Information Management, 23*(2), 71-81.

Galt, K.A., Rule, A.M., Houghton, B., Young, D.O., & Remington, G. (2005). Personal digital assistant-based drug information sources: Potential to improve medication safety [Electronic version]. *Journal of the Medical Library Association, 93*(2), 229-236.

George, L., & Davidson, L. (June, 2005). PDA use in nursing education: Prepared for today, poised for tomorrow. *Online Journal of Nursing Informatics, 9*(2). Retrieved Sept 16, 2005 from http://eaa-knowledge.com/ojni/ni/9_2/george.htm

Goldsworthy, S., Lawrence, N., & Goodman, W. (2006). The use of Personal Digital Assistants at the point of care in an undergraduate nursing program [Electronic version]. *CIN, 24*(3), 138-143.

Hill, T. R., &. Roldan, M. (2005). Toward third generation threaded discussions for mobile learning: Opportunities and challenges for ubiquitous collaborative learning environments. *Information Systems Frontiers, 7*(1), 55-70.

Keegan, D. (2002). *The future of learning: From eLearning to mLearning.* Ericsson.

Keegan, D. (2005, October). *The incorporation of mobile learning into mainstream education and training.* Paper presented at mLearn 2005, the 4th World Conference on Mobile Learning. Cape Town, South Africa.

Koole, M. L. (2005). *The framework for the rational analysis of mobile education (FRAME) model: An evaluation of mobile devices for distance education.* Unpublished master's thesis. Athabasca University, Alberta. Retrieved September 21, 2006, from http://library.athabascau.ca/drr/viewdtr.php?course=thes&id=205

Koole, M. L., & Ally, M. (2006, April). *Framework for the rational analysis of mobile education (FRAME) model: Revising the ABCs of educational practices.* Networking International Conference on Systems and International Conference on Mobile Communications and Learning Technologies, 216 – 216.

Kozma, R.B. (1994). Will media influence learning? Reframing the debate. *Educational Technology, Research and Development, 42*(2), 7 – 19.

Lehman, K. (2003). Clinical nursing instructors' use of handheld computers for student recordkeeping [Electronic version]. *Journal of Nursing Education, 42*(10), 41-42.

Mayes, T., & de Freitas, S. (2004). *Review of e-learning theories, frameworks and models.* Joint Information Systems Committee (JISC) E-Learning Models Desk Study. Retrieved September 21, 2006, from http://www.jisc.ac.uk/uploaded_documents/Stage%202%20Learning%20Models%20(Version%201).pdf#search=%22JISC%20Mayes%22

Miller, J., Shaw-Kokot, J. R., Arnold, M. S., Boggin, T., Crowell, K. E., Allehri, F., Blue, J. H., & Berrier, S. B. (2005). A study of personal digital assistants to enhance undergraduate clinical nursing education. *Journal of Nursing Education, 44*, 19-26.

Newbolt, S. K. (2003, October). New uses for wireless technology. *Nursing Management, 22*, 22-32.

Nyíri, K. (2002). *Towards a philosophy of M-Learning.* IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE 2002). Teleborg Campus, Växjö University, Växjö, Sweden.

Author (2006). [Survey data on mobile use by Nurse Practitioner students]. Unpublished raw data.

Rosenthal, K. (2003). "Touch" vs. "tech": Valuing nursing specific PDA software. *Nursing Management, 34*(7), 58.

Rothschild, J.M., Lee, T.H., Bae, T., & Bates, D.W. (2002). Clinician use of a palmtop drug reference guide [Electronic version]. *Journal of the American Medical Informatics Association, 9*(3), 223-229.

Russell, T. (1999). *The no significant difference phenomenon: A comparative research annotated bibliography on technology for distance education.* Montgomery, AL: The International Distance Education Certification Center.

Metcalf, S.J., & Tinker, R. (n.d.). *TEEMSS: Technology Enhanced Elementary and Middle School Science.* Concord Consortium.

Smith, P. L., & Regan, T. J. (2005). *Instructional Design* (3rd Ed.). Hoboken, N.J: Wiley – Jossey-Bass.

Smordal, O., & Gregory, J. (2003). Personal Digital Assistants in medical education and practice. *Journal of Computer Assisted Learning, 19,* 320-329

Stroud, S.D., Erkel, E.A., & Smith, C.A. (2005). The use of Personal Digital Assistants by Nurse Practitioner students and faculty [Electronic version*]. Journal of the American Academy of Nurse Practitioners, 17*(2), 67-75.

Thomas, B. A., Coppola, J. F., & Feldman, H. (2001). Adopting handheld computers for community-based curriculum: Case study. *Journal of the New York State Nurses Association, 32*, 4-6.

Tooey, M.J., & Mayo, A. (2004, February). Handheld technologies in a clinical setting: State of the technology and resource. *Critical Care Nurse,* 28-36.

Trifonova, A., & Ronchetti M. (2003). A general architecture for M-Learning. J*ournal of Digital Contents, 2*(1), 31-36.

Wagner, E. D. (2005). Enabling mobile learning. *Educause Review, 40*(3), 40-53.

Table One

Comparison of PDA use categories.

Cahoon's (2002) Categories	**Nurse Practitioners (Stroud et. al. , 2005 - 227 respondents)**	**Nurse Practitioners (Author, 2006 - 64 respondents)**
Clinical services	To do list (211 respondents) Memo pad (165 respondents)	Pharmacy and lab related
Calculators	Calculator (369 respondents) Expense tracker (12 respondents)	Calculator
Data collection		Keeping up-to-date
Medical record tools	Calendar/date book (605 respondents)	Calendar
Content tools	Patient management tools (224 respondents) Clinical reference materials (751 respondents) Address/phone book (507 respondents) Information exchange via beaming (113 respondents) Games (92 respondents) Recreational reading (17 respondents)	Referring to texts and guidelines studying
	e-mail (38 respondents) Internet access (15 respondents)	e-mail

Table Two

Nurse Practitioner Insights – Author, 2006.

Reasons to recommend	Barriers to use
1. Valuable with right software	1. Cost
2. Lighter to carry than textbooks	2. Lack of knowledge about technology and software
3. Decrease in medication errors, safer than memory	3. No barriers or don't know of any
4. Convenient, useful tool	4. Difficult to set up
5. Information available is immense and valuable	5. No time to learn
6. Back-up quick reference, security blanket	6. Confidentiality issues
7. Concise and easy to transport	7. Technology failures (batteries die)
8. The way of the future	8. Loss of personal touch
9. Looks professional	9. They aren't necessary
10. Can edit & highlight the most important information & add personal notes	10. They don't teach you to be a Nurse Practitioner
11. You can use it to explore options with client	
12. Organizational benefits	
13. Up-to-date information	
14. Aids mobility	

Table Three

The correspondence between PDA uses and Koole's FRAME model.

Cahoon's (2002) Categories	**Nurse Practitioners' Uses (Stroud et. al., 2005)**	**Nurse Practitioners' Uses (Author, 2006)**	**Corresponding FRAME Model Aspects**
Clinical services	To do list Memo pad	Pharmacy and lab related	Device Usability Aspect
Calculators	Calculator Expense tracker	Calculator	Device Usability Aspect
Data collection		Keeping up-to-date	Learner Aspect
Medical record tools	Calendar/date book	Calendar	Device Usability Aspect
Content tools	Patient management tools Clinical reference materials Address/phone book	Referring to texts and guidelines Studying	Learner Aspect
	Information exchange via beaming		Social Computing
	Games Recreational reading		Learner aspect
	E-mail Internet access	E-mail	Social Computing

From M-learning pilot activity to embedded practice vbnm

From M-learning pilot activity to embedded practice:

using formative evaluation to inform scaled-up implementation

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Abstract

This paper describes the implementation of a mobile learning strategy centred on the use of PDAs by learners in the 9-14 age range having 24/7 access. It is presented from two perspectives. The first is from the practical perspective of project management – that is, the practicalities of engaging and sustaining schools, their management, teachers, parents and pupils in mobile learning. The second is a more formal description of the processes and interactions that describe mobile learning embedded in schools and beyond. The formal model draws together the important variables that impact on mobile learning as it may be implemented within a school's pedagogical vision. From the school-centred account, we move to a description of the wider engagement of schools within a Local Authority as exemplified by Wolverhampton's 'Learning2Go' project. The considerations to be taken into account in engaging, managing and sustaining mobile learning practices in a cohort of schools in which over one thousand handheld devices are in use are discussed. Practical factors to be taken into account in this wider roll-out include national political imperatives as well as large-scale training, technical support and ensuring the sustainability of the model. The paper moves to consider the educational rewards and outcomes of these efforts. The education system in England has an in-built monitoring system in the form of end of key stage tests. Some of the challenges and opportunities of attempting to measure the outcomes of innovative practices using traditional pencil and paper tests are discussed. The particular support that mobile learning offers to a pedagogy in which formative assessment plays a key role is discussed.

From M-learning pilot activity to embedded practice: using formative evaluation to inform scaled-up implementation

Introduction

The Learning2Go project is centred in Wolverhampton, an urban conurbation in the industrial heartland of England, characterized by areas of severe deprivation, an ethnically diverse population and 'digital divide'. The paper discusses how such an initiative has managed to thrive and attract a growing interest and considers against what criteria valid and reliable evaluation evidence might be collected. Important considerations include the diverse range of stakeholders and the particular interests of different stakeholding groups.

'Mobile learning' is a term used to define the type of learning that takes place when the learner has some kind of mobile handheld computer such as a PDA, Smartphone, tablet PC, games console or other portable device and is able to make use of the appliance, its connectivity, tools and content to learn at a time and place of their own choosing. Some of the recent trends in this area are described by van der Merwe and Brown (2005). The 'Learning2Go' project uses mobile handheld computers to engage learners by delivering multimedia content, Internet and authoring tools. It delivers 24/7 personalised learning and gives learners the choice to learn when they want, how they want and where they want. Learning2Go involves teachers, learners and their families. It also has involved collaboration between Wolverhampton Local Authority, prominent hardware and software manufacturers, academics and government agencies that are keen to research the impact and development of mobile learning.

The following features characterise the project ethos:

- The learner 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 the schools
- 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.

Heeding the 'learner voice' has been a key consideration and the Learning2Go project embodies a core 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 each learner takes responsibility for managing their own mobile handheld computer and has a share in the shaping of their own learning. Learners have had a major input into the ethos, direction and development of the project.

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 learner 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.

For the most part, this paper offers descriptive and ethnographic evidence for these claims as a pre-cursor to systematic research. To describe the nature of the innovation more fully, it is necessary to consider not just teachers and learners but also school systems as well as links to home and learners' life needs. It would be very difficult for a teacher within a school to operate mobile learning in isolation. School senior managers and governors will formulate a plan based on their vision of what they wish to achieve in terms of embedding ICT. To help them review their needs, various supporting documents have been put in place in the UK. For example, Becta has developed a Self Review Framework (Becta 2006a). There is also a website http://www.matrix.ncsl.org.uk that offers guidance, the 'matrix' being an online tool developed by the National College for School Leadership and Becta that facilitates self-evaluation and planning. The matrix can be used by a school to review its current position against a set of statements. As the statements are completed, an action plan is generated.

The reality of translating a school's vision into practical operations requires funding and may be constrained by previous investment, the nature of school buildings, and so on. In the context of introducing mobile learning, it may be necessary to accept that 'legacy equipment' may include suites of desktop computers. Involving teachers in decision-making around matters that will impinge in fundamental ways on their classroom practices requires the allocation of time and resources. It would be usual for delegated responsibility for translating school policy into action to be mediated by ICT co-ordinators. These specialist teachers would be likely to

have responsibility for identifying teachers' training needs, perhaps providing some of that training themselves as well as supporting staff development more widely by accessing available resources. With these elements in place, we may expect to see 'embedded' ICT-mediated learning in classrooms. Such an embedded scenario is illustrated diagrammatically in Figure 1.

[INSERT FIGURE 1 ABOUT HERE]

ICT practices are defined as being embedded in classrooms when they take second place to the teacher's pedagogical concerns about what is being taught and the manner of its teaching, (see for example, Russell and McGuigan, 2006) and when pupils select digital resources from available tools, as and when they decide they need them to support their learning. That is, ICT is not an end in itself but is subsumed to the content and processes of teaching and learning as a set of enabling resources. Of course, when exposed to such an environment, pupils' ICT skills invariably advance at pace – sometimes at an astonishingly fast pace, but that outcome is incidental added value to the primary teaching objectives. Two classroom scenarios can succinctly illustrate what we have in mind.

Illustration 1. *A secondary science laboratory proceeds with an investigation of the neutralisation of an acid solution. The teacher has the lesson objective summarised on the IWB and pupils use their PDAs to video-record the colour change in the indicator. They also record their results using Pocket Word or Excel. Using 'Dot Pocket' to link her PDA to the IWB, the teacher locates an Internet site that offers pupils brief revision exercises, making the point that they may access such a site at any time during the day using wireless access.*

Illustration 2. *A primary teacher conducts an indoor hockey game. Those pupils not directly involved in a game at any time engage in literacy activities – commentating on the game*

(using observation and verbal analysis). Other language genres are used – journalistic reporting and oral interviews which are also video-recorded or which use digital still images for illustration. Excel is used to record scores and to construct league tables of results. The Physical Education aspect – apart from the direct experience of the game and the deployment of skills – will be analysed by children later, using video-analysis of techniques of positioning, stopping, turning and hitting the puck.

Depending on the school's choice of hardware, software and provision of access to a wireless network, great leaps forward can be offered to pupils in terms of their access to mobile learning opportunities. With 24/7 access, the bridging of the digital divide unleashes a radical innovation in allowing pupils ownership and control of the technology. Whereas such bridging might have been anticipated as opening access from centre to periphery (or put another way, from the establishment to the masses) what we actually observe is an equal or greater flow of user knowledge and expertise from the periphery to the centre. Pupils' knowledge and control of digital resources in their informal home and cultural lives floods back into the formal educational system. What is apparent from the Learning2Go experience is that learners' mastery of the digital resource is motivated by their own 'life needs'. That is, the interest in communicating with friends, accessing music, computer games, photographing and video-recording family and peers and other such pursuits drive the achievement of proficiency at a far greater rate than schools would expect in other contexts, for example, acquisition of ICT skills in a computer laboratory. A great deal of peer-to-peer mentoring is in evidence as well as software sharing, mutual technical support and problem solving. Not least, for many families, a child's PDA ownership initiates a family interest in ICT - a burgeoning curiosity that is supported and nurtured by school-based activities of various kinds in Wolverhampton.

The addition of some form of school Information Management System (IMS) extends possibilities still further, as illustrated in Figure 2. With the potential inclusion of a ‘learning platform’ and virtual space for e-portfolios, it is possible to arrive at a cycle in which performance data can be collected at the system level, to be used to inform refinement of the system itself. For example, the impact on learners’ achievements of various teacher interventions can be monitored through the learning platform and this information used to inform elaboration of the school’s vision of what is effective within its own particular context.

[INSERT FIGURE 2 ABOUT HERE]

The developments described above are of enormous interest and excitement to educators who have seen pupils’ control of and engagement with the technology at first hand. It is as though what ICT has promised to education for so many years is at last becoming a reality, with the opportunity for pedagogical objectives to subsume the technical wherewithal, rather than the converse. Perhaps because technology has promised so much for so long, the current situation is that mobile learning must next prove its efficacy with hard evidence rather than by reference to the enthusiasm and commitment of its evangelists.

It is possible to identify three phases in the development of schools' and teachers' implementation of the practices described, as tentative ideas that could be the subject of a more systematic formative evaluation.

1. In the first phase, matters are at their most experimental and the fundamental question is likely to be, ‘Can we get this potentially useful technology to work in schools and classrooms?’ The introduction of ICT in this first phase is likely to be in parallel with

pedagogical concerns, with attempts made to complement one with the other. Proceedings may be on the basis of trial and error and serendipity – the final outcomes will not be known.

2. The second phase can proceed with greater certainty because the characteristics of the digital resources are of known quality and reliability. At this point, pedagogical concerns can determine the quality of teaching and learning events in the classroom. The ICT is subsumed to, and is in the service of, the teacher's educational agenda. Some teachers describe the ICT as becoming 'transparent' at this point, meaning that classroom interactions are foregrounded. It may well be the case that the efficacy of learning outcomes is an unknown in this phase, because it is only when control of the digital resource has been mastered that its impact on learning may be judged.

3. In the third phase, the scattergun approach of the phase 2 'We know it works, so let's see what we can do with it.' can be displaced by a better informed and more closely targeted set of strategies. ICT will be used *selectively* and more *purposefully* to target the differentiated needs of pupils.

[INSERT FIGURE 3 ABOUT HERE]

Currently, in Wolverhampton, some teachers have aspects of the third phase in their repertoire of practices. The present need is to carry out an audit of these exemplary practices, in order to describe them fully and disseminate them more widely as an inspirational resource for colleagues to adopt and develop to their own needs.

One further point to make about these three phases is that, when new technology is introduced – for example, plug-in data loggers, GPS or wireless linkage to the IWB, it may be

that teachers drop back to the first phase to learn the possibilities and idiosyncrasies of the new resource before taking control of it and finally, using it in a more precisely targeted manner.

Issues to be addressed in scaling up the Learning2Go project

What we have discussed up to this point can be used to describe developments within a single school. The scaling up and consolidation of the programme in a Local Authority such as Wolverhampton must take into account the needs of a cohort of schools, and several issues need to be addressed:

i. establishing consonance with the wider governmental strategy and educational vision;
ii. the design and implementation of a sustainable funding model;
iii. training and support for teachers;
iv. technical support for the system and its users;
v. the provision of personalised learning space.

Educational vision and consultation processes with schools

As with all innovation projects, it is important to have a well defined shared vision with school leaders, and this will influence the scaling up of the project. As the aims of the project are firmly embedded in the educational, social and emotional needs of learners rather than in a piece of technology, it is easier to share the perceived benefits and ethos. The Learning2Go project has at its heart the ambitions of the Government's e-strategy and the five goals of the Children's Act 2004, (www.everychildmatters.gov.uk).

- Being healthy
- Staying Safe
- Enjoying and achieving
- Making a positive contribution
- Achieve economic well being.

With this ethos at its core the Learning2Go project has been seen by the early adopters as a means of delivering many of the current educational challenges for their school and school community. Enabling the headteachers to visit and meet with lead teachers and their learners has been an essential ingredient in terms of disseminating the project beyond the initial phase 1 schools. Phase 3 schools include a larger proportion of secondary schools and this has been a direct response to a realisation that the learners entering Year 7 (induction year for secondary pupils in England) would have substantial technological ability which should be built upon. A further catalyst to encourage schools that have not yet come on board has been the publication of an external formative evaluation of the project (Perry, 2005) and the recognition that a total package including training, support, technical assistance, funding models and content and software development has become available. Those schools that have yet to join the project are waiting to review outcomes and time their possible involvement to coincide with their own in-school priorities. Some schools see the use of handhelds as part of a continuum of steps gradually embedding technology into teaching and learning, moving from i), a suite of desktop computers to ii) a complementary set of wireless-enabled laptops and iii) a wired main network supplemented by wireless laptops and handheld devices.

Funding and sustainability model

Learning2Go is innovative in the way it uses technology, but also in the way that it arranges funding. In order to enable learners to have their own personal handheld computer, the model used is one of joint funding between schools and parents. The system is familiar to schools in that it works in a similar way to the arrangement they use for funding pupils' out-of-school educational visits. Parents make a contribution while the school will subsidise with money from its own budget resources, in order to make the whole package financially attractive and accessible to all pupils.

Initially, Learning2Go was funded totally by the Wolverhampton Local Authority. Parents were asked at the end of the project's pilot phase whether they would be prepared to make a contribution to their children owning their device. In the light of positive feedback, a phase 2 model was put forward which asked parents for a contribution. An indication of the scale of that contribution relative to many families' expenditure was to express it in terms of the equivalent of 'a pint of beer a week or a packet of cigarettes a fortnight'. Any shortfall in funding was then to be made good by the school, and supplemented by gift aid contributions from the E-Learning Foundation.

The current funding model is based on a two year cycle, jointly funded by the school and parents, the latter being invited to make one hundred payments over that period. The short product replacement cycle of mobile devices is a consideration, with PDAs being more akin to mobile telephones (which have an even shorter product replacement cycle of perhaps one year) than desktop computers. Insurance is included in the price of the device and is jointly funded, as

described above. In addition, digital content and a memory card are eligible for funding by the school using government-funded e-learning credits. Further added value is provided by the school in the shape of a wireless infrastructure.

There have been various interpretations of this model by schools – more variations on a theme than radical departures. The typical model adopted by primary schools has been to begin the project in Year 5 (with pupils of 9-10 years of age) and allow it to run for two years with learners taking devices into their sixth year of schooling. Forward-looking secondary schools have joint-funded devices in Year 6, taking the devices through the pupils' transfer to secondary education at Year 7, thereby creating an interesting model of continuity in transition. These methods of funding are exploratory innovations and, as such, are changing and developing continuously in the light of experience.

A key enabling partner in the funding is the E-Learning Foundation which is a registered charity, (http://www.e-learningfoundation.com/). The Foundation aims to reduce the 'digital divide' by working with schools, parents and others to ensure that all children have access to the learning resources that technology can make available, when and where they need them, both at home and at school, with equity of access a priority. As the Foundation is endorsed by the UK government, adoption of the scheme by local Wolverhampton Council members was a realistic proposition. The donations made by parents through their children's schools attract 'Gift Aid' as long as the scheme is equitable - charities registered with the Charity Commission may claim repayment of tax under this scheme provided the conditions for the Gift Aid tax relief are

satisfied. Schools are then eligible for grant support from the Foundation, which also bears the costs of administrating the scheme.

Technical issues

Involvement in a mobile learning project will place extra demands on the current level of technical support that an establishment requires. One of the main technical aspects that has to be dealt with is the wireless connectivity on the school's site. In order to get the maximum benefits from their handheld devices, learners need to be connected to a robust and reliable wireless LAN which connects to the high bandwidth schools broadband network. The Learning2Go project is currently using a system that enables more than 30 devices to be connected concurrently. This facility is becoming increasingly important as the project begins to use collaborative learning, voting and display systems which require that all class devices be simultaneously connected.

From the learner's perspective, technical support needs to be so good that the devices work dependably. An interesting and unexpected outcome has been the extent to which learners themselves have developed technical competence. In providing young learners with a sophisticated handheld computer 24/7, the Learning2Go project has facilitated their ICT capability in a way that traditional lessons in the ICT suite never could. The learners have had to acquire 21st century skills such as synchronising their data to their user area on the school's network, closing down running programmes to conserve battery, connecting to the Internet wirelessly, using bluetooth technology to beam files to their friends and making sure they come to school with their device's battery fully charged. Another key factor in the project's success has

been the ability to connect the devices to the interactive whiteboard and projector, both for teacher demonstrations and for learner presentations.

Training

Staff professional development is key to the success of any innovation in a learning establishment. The evidence suggests that teachers feel that they have a continuing need for continuing professional development in ICT (Becta, 2006b). Schools have to allow enough funds for Professional development with ICT projects. Part of the commitment to the Learning 2 Go project was an assurance by school leaders that staff would take advantage of the linked professional development package, which offers the following:

- each teacher received 3 x half days introductory training in the first half term;
- Session1 – Teacher receives personal device;
- Session2 – Teacher receives content;
- Session3 – Teacher receives planned activities and picks up learners devices;
- half day per half term training for rest of the year;
- Total to schools 8 x half days = 4 days total teacher replacement requirement.

In addition the following support was put into place building on previous success with embedding technology via a personalised training model called, 'Hands on Support':

- access to expert members of staff from phase 1 to support the project;
- construction of 'What works' Scenarios;

- modeling of the key features of an M-learning classroom;
- 'Little and often' training following the Wolverhampton 'Hands on Support' Model;
- routine day-to-day management of the devices.

In January 2006, an external evaluator, David Perry, observed the rapid adoption of the handheld devices in the majority of Learning2Go schools commenting:

“The outstanding development has been the pace at which the project roll-out has established itself, and along with this, how soon new schools start taking their use of handhelds into new territory. It must say a great deal about the technology (as well as the teachers) that this is happening so rapidly – so this is the major theme of this report. Whilst the Authority has done a great deal to publicise the project, if anything, it is my view as evaluator that the benefits of the scheme are being under- rather than over-stated. Their success rests significantly on the support package.” (Perry, 2006)

Perry identified the effective use of 'lead teachers' from phase 1 and the engagement in training as being key to the successful embedding of handhelds in the teaching and learning environment.

In the Autumn term 2005, as the second phase of the project began, the two teachers involved in the previous year were seconded to the authority for two days a week each to induct new teachers and visit schools to give them initial support. An adult education consultant also joined the support team, bringing expansion possibilities in that area. A programme of half-day

training sessions was implemented based on experience in the pilot phase and many background tasks were undertaken by the team to ease entry to the project for new teachers. These included for example, creating coordinated domain names for the different schools with standard registration procedures for each child; identifying new software applications and training in the basics of the operating system. Actions such as these are essential if the project is to stay organised through the large scale roll-out and be sustainable over time. Such overheads are a necessity rather than a luxury to ensure that project activities and procedures become an integrated part of normal working.

Efficacy of project learning outcomes

There are dilemmas facing educational evaluators who seek to draw inferences about the efficacy of innovative practices in schools. The more radical the changes in practice, the more difficult these issues become. How is the efficacy of mobile learning to be evaluated? Before attempting an answer to this question, we have to be clear who it is that needs to be persuaded. Pupils seem to be enthusiastic, but of course, if the handheld devices with which they have been provided meet their 'life needs', this will contaminate their view of the educational advantages. Parents seem to recognise advantages, but are likely to refer to a broader spectrum of criteria than educationalists. The critical people to be persuaded are the policy makers. Learning targets have been in place for many years in England, as well national curriculum tests as the means of assessing whether those targets have been reached. While 'high stakes' tests have their critics, policy-makers are unlikely to desist from auditing the education system by reference to pupil learning outcomes. It is more likely that they might be persuaded to examine the different *qualities* of outcomes achieved by M-learners. Research is needed to compare traditional pencil

and paper assessment with multimedia versions of the same demands fed through mobile devices, to offer insights into any differences associated with M-learning innovations.

Formative assessment practices, on the other hand, have established significant correlations with educational gains, (Black and Wiliam, 2006). Although from one perspective mobile devices offer consummately individual and personalised learning experiences, their educational efficacy is likely to be greatly amplified when the learner is networked into an extensive database or 'learning platform'. Such systems open the prospect of greatly enriched teacher assessment, the supporting evidence for pupil achievements being hyperlinked to virtual records of achievement. Wireless-networked devices can facilitate teachers' use of assessment for learning as well as pupils' self-review by making richly illustrated exemplification of past achievements and future targets available in e-portfolios. Indeed, set against such rich possibilities, traditional pencil and paper summative assessment evidence offers relatively impoverished evidence of M-learning outcomes. The notion of 'e-maturity' can be thought of as a characteristic not just of a learner or of a teacher, but also of an institution or a school system.

Shifting the focus of discussion from systems for recording outcomes to classroom processes, another radically innovative dimension of M-learning practice is deserving of analysis and evaluation. Learners' possession of individual devices invites possibilities of sharing ideas through the class IWB. Teachers' adoption of constructivist approaches to teaching and learning benefit from the rapid elicitation of and access to the ideas of all learners in a group or class via mobile devices. The multimedia representations available through M-learning devices offer unparalleled scope for learners to make their ideas known in whatever style they favour: using

words, numbers, sound, video, audio, animations, etc. Transactions around the expression of these ideas can be one-to-one, one-to-many, many-to-many or many-to-one (e.g. all learners to the teacher). For example, learners can present their ideas through the IWB and teachers can select from a group array in order to seek elaboration, justification, levels of agreement from peers, etc. A range of possibilities is beginning to emerge using wireless technology and software innovation that allows polling, 'open' responses and screen sharing through the IWB, as well as collaborative decision-making. These new communication tools offer unprecedented transparency to teachers and learners for ideas-sharing.

Despite some obvious attractions, the desire to scale up exciting innovation does not suggest a straightforward expansion. In the case of embedded M-learning, early adopting institutions are not necessarily representative of schools as a whole. Unless deliberately canvassed, little, if anything, will be known about the strategic thinking of those schools that have not yet availed themselves of the opportunity to engage with mobile learning. There is something to be learned from the insights of marketing in the context of consumers' purchasing and adoption of innovative technology. Moore (2002) suggests that the 'early majority' (the 'pragmatists' who follow the first wave of 'early adopters') rarely reference the early adopters in their decision-making that may lead them to follow the same path. The suggestion is that the second wave needs to be convinced of the advantages of adoption in their own terms and in the context of their habitual ways of operating. Put another way, they need to be persuaded of the pragmatics of adoption. In marketing terms, they must be regarded as a separate market segment in any scaling-up strategy[i]. Translated to the perspective of later-adopting teachers, there needs

to be persuasive pragmatic evidence that M-learning generates the kinds of practical outcomes that they find worthy of pursuit.

Given the radical nature of an innovation such as Learning2Go, an evaluation based on the pre-suppositions of traditional practices is likely to be inappropriately restrictive. There is a need to be open to the possibility of innovative uses and outcomes that might not have been on the formal educational agenda - a requirement to look for the unexpected. This stance will be in conflict with the performance criteria adopted by policy-makers – the signs of successful educational investment will tend to refer to traditional outcomes and practices. The ‘bottom line’ (or, in research terms, the crucial dependent variable) will be standards of pupil achievement – currently in England, as measured by end of key stage tests. However, innovative practices with novel hardware and software do not emerge fully-fledged. Though radical in parts, there are areas of under-exploitation as well as successes that must be propagated. An iterative action-research methodology, rather than an ‘arm’s length’ evaluation, is more likely to suit practitioners’ needs. Furthermore, given an intrinsically dynamic scenario, the management of change process has to be factored in, rather than assuming a static, ‘experimental’ stance. A way forward is to adopt mixed qualitative and quantitative methods, within a collaborative action-research model, in which the complementary skills of researchers and classroom practitioners inform one another around grounded practice. Within this mode of operating, traditional criteria denoting pupil achievements as well as innovative ‘blue skies’ outcomes can be accommodated.

References

Becta (2006a). *School improvement through ICT.* Retrieved November 24, 2006, from http://partners.becta.org.uk/index.php?section=en&catcode=_en_bp_02

Becta (2006b). *The Becta Review 2006.* The British Educational Communications and Technology Agency.

Black, P.J. and Wiliam, D. (2006) Developing a theory of formative assessment. (In J. Gardner (Ed.) *Assessment and learning* (pp. 81-100). London: Sage)

TSO (2003*) Every child matters* Presented to parliament by the chief secretary to the treasury by command of Her Majesty September 2003. Retrieved November 24, 2006, from http://www.everychildmatters.gov.uk/_files/EBE7EEAC90382663E0D5BBF24C99A7AC.pdf London: The Stationery Office.

Moore, G.A. (2002) *Crossing the Chasm: Marketing and Selling Disruptive Products to Mainstream Customers.* New York: Harper Collins Business Essentials.

Perry, D. L. (2005). *I was pants at IT.* Wolverhampton LEA 'Learning2Go' Mobile Learning-PDAs in Schools Project, Evaluation Phase 1 End of First Year Report August 2005, david perry associates. Retrieved November 24, 2006, from http://www.learning2go.org/media/download_gallery/dpaReport1.pdf

Perry, D. (2006). *Harnessing technology in Wolverhampton* Wolverhampton Learning2Go Mobile Learning-PDAs in Schools Project, Initial Report Phase II report. January 2006, david perry associates. Retrieved November 24, 2006, from http://www.learning2go.org/media/download_gallery/dpaPh2InitialReport.pdf

Russell, T. and McGuigan, L. (2006) Science through ICT: an examination of leading-edge practice with BETT award-winning ICT products. Becta. http://www.becta.org.uk/research/reports

van der Merwe, H. and Brown, T. (2005). *Mobile Technology: The future of learning in your hands.* Conference proceedings mLearn 2005. 4th World Conference on mLearning. Cape Town, South Africa. October 25-28, 2005.

Footnotes

[i] Thanks to Mark Bird of Steljes Limited UK for drawing our attention to the interesting parallels between marketing and educational innovation centred on novel technology.

Figure Captions

Figure 1. Pedagogical vision underlying embedded mobile learning practices

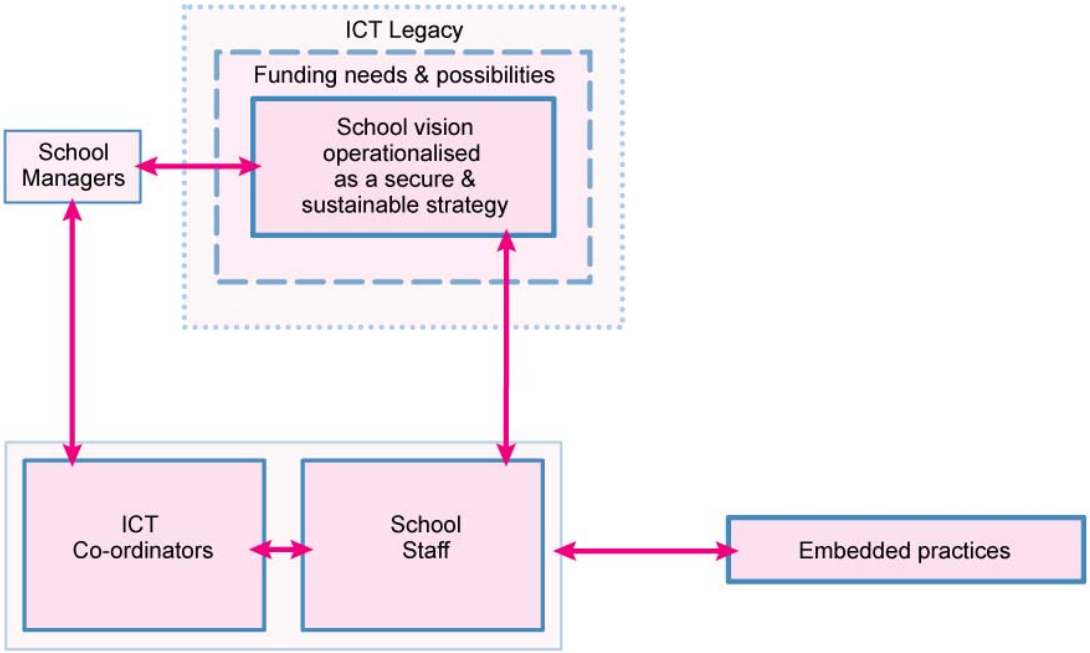


Figure 2. The addition of an Information Management System and support for e-portfolios

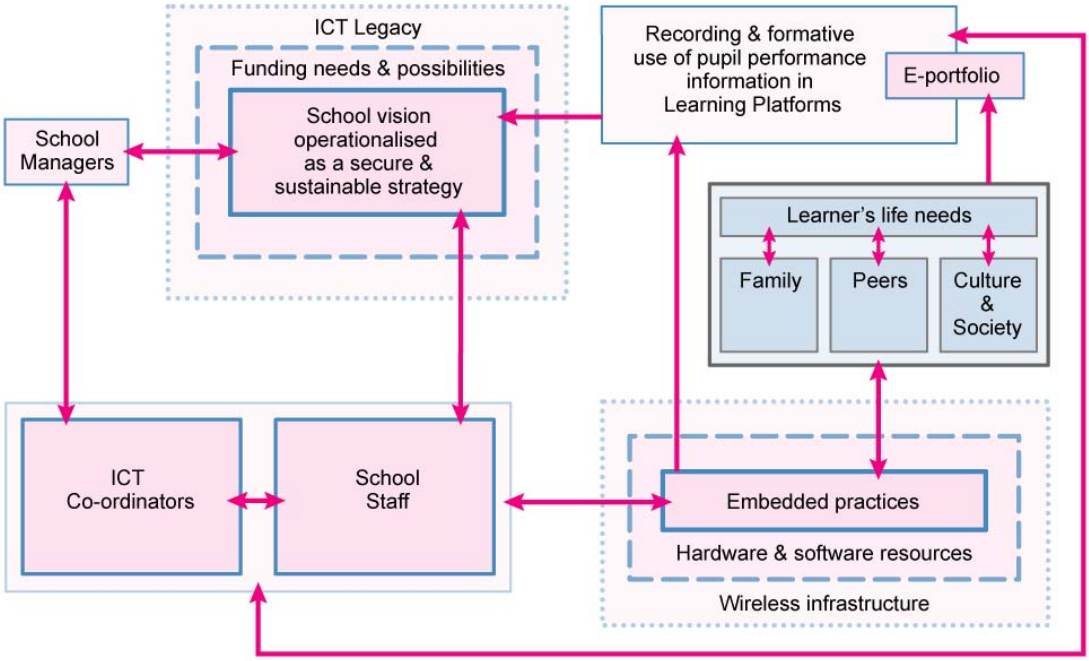
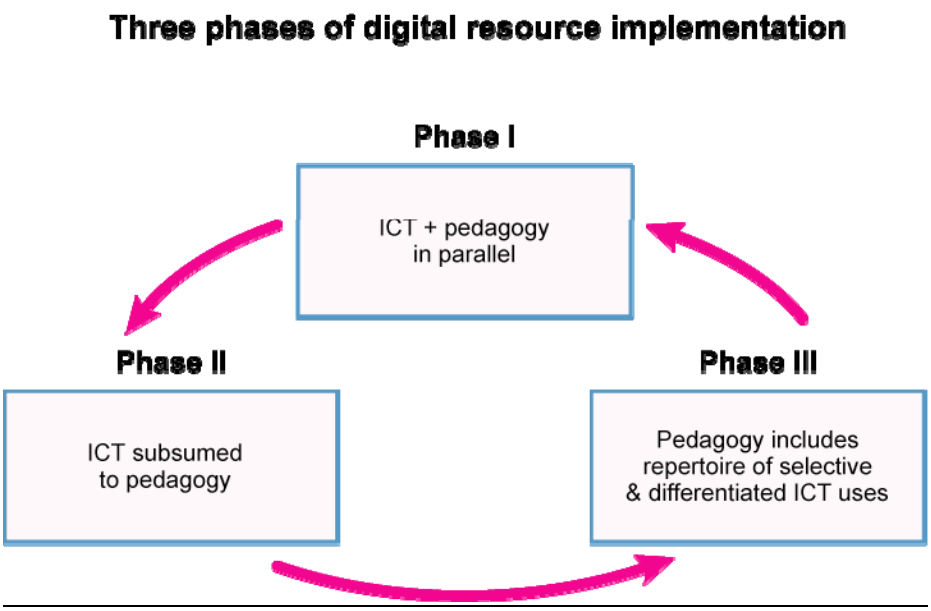


Figure 3. Three phases of digital resource implementation



RESEARCHING MOBILE LEARNING WITH COLLEGE TUTORS – OPERATIONAL ISSUES, LESSONS LEARNED AND FINDINGS

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Abstract

Many educators are becoming interested in mobile learning as an alternative, or supplementary, way of delivering aspects of teaching and learning, or as a conduit to lead 'disengaged' youth to further learning, or as a mixture of both. This paper describes the Mobile Learning Teachers' Toolkit project, where 19 UK college tutors were able to author their own mobile learning materials to cater for the specific needs of their students in their particular context. Also discussed are the challenges involved in setting up a mobile learning project, and some of the lessons learned.

1 Introduction

This project builds on the experiences of the m-learning project (http://www.m-learning.org). m-Learning was a three-year pan-European research and development project which used handheld technologies to provide literacy and numeracy learning experiences for hard-to-reach young adults (aged 16–24) who were not in full-time education and to promote the development and achievement of lifelong learning objectives. The m-learning project focused on the experience of the young adults involved, and project findings can be found in Attewell (2005).

Since the m-learning project finished in 2004, two of the partners, Learning and Skills Network (LSN, formerly Learning and Skills Development Agency) and Tribal Cambridge Training and Development (CTAD), have taken forward the learning materials and systems work by developing a toolkit of three applications which teachers and tutors can use to author their own mobile learning materials and quizzes. This is in direct response to the findings of the m-learning project, ie that tutors want ownership and involvement, they want resources which are appropriate for their learners, the subject and curriculum being taught, at the right level, in the right context, and suitable for the teaching and learning environment. Thus a toolkit was developed with the aim of:

> "enabling providers to develop mobile learning materials for their particular students and context, to evaluate the toolkit and to develop advice and case studies to share good practice".

2 Research and Operational Issues

During the project, LSN and CTAD explored the tutors' reactions to the toolkit and, in particular, their perceptions of:

a) How use of the toolkit impacted on their teaching
b) How use of the toolkit impacted on their students' learning and interest in learning
c) How use of the toolkit was integrated into the curriculum for their students

Therefore, the main focus was on the experiences of the tutors involved, rather than that of their students (although any data received from the students was incorporated).

A number of colleges were approached to take part in the research project by LSN, some of which had taken part in mobile learning projects previously, and others which were new to mobile learning. Five colleges were recruited to the project, three in the North of England, one in the West of England and one in Wales. At the start 26 tutors agreed to take part, although by the end only 19 tutors had actively used the toolkit. Two tutors withdrew because an impending college inspection curtailed their involvement, three withdrew because of a shortage of time to participate because of college teaching demands, one had an accident requiring hospitalisation and one used the mobile device but not for anything connected with the project. Thus 19 tutors completed the project (some of whom had no previous use of using a palmtop computer), and who taught a variety of subjects such as childcare, literacy, numeracy, e-learning and learning technology, English for Speakers of Other Languages (ESOL), English as a Foreign Language (EFL), computing, media production, business studies, special needs, hospitality and key skills. There were 14 female tutors and 5 male tutors, and the main research period was January to April 2006.

Due to the small-scale nature of the research and the wide geographical distribution of the tutors, it was decided that questionnaires were the most practical way of collecting the data. Pre- and post-use questionnaires were used, containing a mixture of open and closed questions to allow both ease of completion and the opportunity to add personal thoughts and experiences as relevant. The questionnaire data was supplemented by data gathered from the tutors' use of the extranet[1] and, at the end of the project, the tutors were asked to describe and supply copies of their most successful games, quizzes and mediaBoards as examples of good practice for others interested in mobile learning.

Importance was placed on training for the staff involved in how to use the PDAs, the toolkit and the research activities which would be required. A one-day workshop was held with the co-ordinators in each college who were unknown to the project team, and a one or two-day training session for the tutors taking part (to fit in with local requirements and taking into account that it needed to be organised around teaching commitments and part-time staff are only available on certain days). The tutors were

[1] An extranet is a password-protected website, which uses internet technology to share documents securely and to facilitate collaboration, discussion and support.

given background information about the project, explanatory guides on the tools and the PDAs, and encouraged to use a dedicated extranet site which allowed all the tutors to communicate with each other and the project team and share resources.

All staff who took part were given PDAs. These were XDAIIs, which were originally used in the m-learning project, and were fitted with prepaid (or pay-as-you-go) SIM cards by the network providers who were considered to offer the best service in each location where the PDA would be used. Tutors needed to have access to PDAs in order to test fully the games which they might design, as they were created on a PC and downloaded directly to the PDAs. PDAs could be borrowed by tutors, so that they could use the games with their students. A set of ten were available from the project team and several of the colleges involved also had PDAs available for tutors to borrow. For the creation of SMS quizzes and mediaBoards, PDAs were not required, the tutors only needed access to the PC, and then the students would use their own mobile phones to take part for which they would be reimbursed.

Although it was not possible to offer colleges any money for participating in the project, it was agreed that the tutors who took part in the project and who returned the research data required, could keep the devices at the end of the project. In all but two cases this happened, but one college insisted that the devices used by the tutors became college property at the end.

One of the findings from the m-learning project, was that it is important to support the people involved in mobile learning projects in order to ensure that any problems are dealt with quickly (Attewell, 2005). First-line support was offered by two LSDA staff, who were available by telephone, e-mail and mobile phone. Help was also available through the project's extranet, text messages were sent to tutors asking if they had any problems, and a consultant visited some colleges in order to resolve MMS problems which were difficult to address remotely (see section 5.3).

3 The Mobile Learning Toolkit

This section describes the 3 applications provided in the toolkit, namely the SMS quiz engine, the mediaBoard and the learning games. A brief description of each tool is noted below, together with an example of the work created by the tutors for use by their students.

3.1 The SMS quiz engine

The SMS authoring tool allowed tutors to prepare multiple-choice quizzes which their learners could access using their own mobile phones. Such quizzes are designed online, using a desktop computer, and then students text their answers in a numerical string to a specific address and received an automated response designed by the tutor (who also had the ability to send up to 7 daily follow-up messages after the initial text message had been sent). The tutors were able to access a reporting function of the tool in order to see the answers received from different mobile phone numbers (so the tutors needed to know these in advance) and the date/time messages were sent. Arrangements were made with the tutors to reimburse learners for taking part in these activities using their own mobile phones.

By the end of the project, the tutors reported that 36 quizzes had been created, which took 58.5 hours, and were played 328 times by the students (NB this is the number of times quizzes were played, not the total number of students taking part because some students played several quizzes). More than half the tutors said it was either "*very easy*", or "*easy*" to create quizzes, and tutors stated that the questions which were devised were the single most important success factor for its use.

The following is an example of one of the SMS quizzes created by a tutor for the National Diploma in Animal Management course at level 3. Eleven students independently used the quiz, where the tutor used it to test learning during a teaching session. The questions and possible alternative answers are shown below with the correct answers underlined. The students responded with an SMS message including the answer numbers, ie a student texting 32341 would have 5 correct answers.

A. What is an ectoparasite?
1. A disease that affects parasites
2. A treatment for killing parasites
3. A parasite that lives on the outside of the body
4. A person responsible for recording parasite occurrence

B. Fleas and lice are….?
1. members of the teleost group
2. insects
3. arachnids
4. related to woodlice

C. Lice have eggs which…….
1. roll off the host as soon as they are laid
2. are spherical and are laid in clumps
3. Remain tightly glued to the base of the hair
4. are easily removed by light grooming

D. Tapeworms have……..
1. a well developed digestive system
2. a body with no clear segmentation
3. complex dances to attract mates
4. segments that are shed daily containing thousands of eggs

E. Which of the following is a common tapeworm of dogs and cats
1. *Dipylidium caninum*
2. *Architeuthis pseudoargus*
3. *Alca torda*
4. *Toxocara canis*

The following table shows the automated answers the students would receive depending upon the number of correct answers they gave. Therefore, if the student had only one correct answer, they would receive the second message in the table. It was also possible for the system to insert some information into the reply automatically (eg the response format 'you scored ###/5 and got *** right' might generate a message to the learner stating 'you scored 3/5 and got A, C and D right').

The example below was created by a tutor in a college in Wales and, therefore, the feedback is provided in both English and Welsh languages.

○ 0	○ 1	○ 2	○ 3	○ 4	○ 5	
•						You got #/5. It's probably time to check your notes and try again later! #/5 Amser edrych ar y nodiadau a ceisio eto!
	•					You only got * correct. Check through your notes and try again later #/5 Amser edrych ar y nodiadau a ceisio eto!
		•				You only got ** correct. Check through your notes and try again later. Atebion ** yn gywir. Edrychwch ar y nodiadau cyn ceisio eto.
			•			You got #/5 correct. Answers *** were correct. #/5 yn iawn. Oedd atebion *** yn iawn.
				•		You got **** correct ! Check the wrong answer in your notes. **** yn iawn ! Edrychwch yn y nodiadau am yr ateb arall.
					•	All answers correct, well done! Atebion I gyd yn iawn, Da iawn!

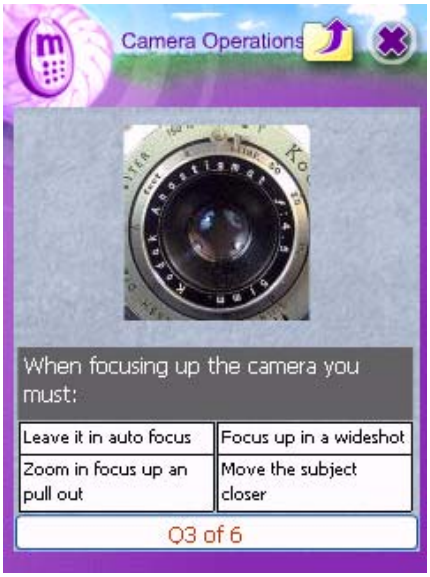
Afterwards the tutor reflected that this activity allowed the students to undertake learning activities, and retry them, getting feedback when not in the classroom. As a different type of activity it "*stimulated their interest*" in learning.

3.2 The MyLearning games authoring system

A number of games were developed for use on the PDAs by tutors using the authoring system on their PCs. These were then download to the PDAs either using the docking station or the SSD (small disks) provided. As the use of these games was not dependent on online access the students did not incur any charges themselves for using them. Tutors could create simple card games including pairs games (where 8 or 12 cards showing images, text, or a combination of both are displayed on screen and turned over so the learner has to remember and indicate where the matching pairs were) and snap games, as well as multiple-choice quizzes including pictures and text.

By the end of the project, the tutors reported that 31 games had been created, which took 42 hours, and were played 288 times by the students (124 for the pairs games, 92 for the snap games and 72 for the quiz games). More than half the tutors rated the experience of creating all types of games as "*fine*". Tutors stated that the importance of the games being appropriate and relevant in terms of learning and the subject studied were the most important factors affecting their use.

The following is an example of a quiz game created by a tutor for the National Diploma in Media Production at level 3. Twelve students working independently used the game, where it was used in question and answer sessions and the tutor considered it made the session "*more attractive to learners*".



3.3 The mediaBoard

The mediaBoard can be envisaged as being similar to an Internet message board, in that the tutor creates an image on a web page using a desktop computer (PC). This image can be a picture or diagram, such as a local map of the area. The students can then take part in a collaborative exercise including sending text and multimedia (picture and audio) messages to the map and to different themes relating to the board (eg locations on the map). An example of this is students exploring their local area, taking photos which they send to the appropriate location on a map, upon which they can receive a text message alerting them to visit another location with a task and so on. Such messages can then be viewed online back at college, where accompanying text can be added and changed. As with the SMS quiz engine above, the cost of the learners using their own devices to send SMS/MMS messages to the mediaBoards was reimbursed.

By the end of the project, the tutors reported that 28 mediaBoards had been partially or fully created, which took 25 hours, and were accessed by 57 students. However, because of problems related to difficulties in sending and receiving MMS messages (see section 5.3), the mediaBoard facility was not used as much as was hoped. Most tutors gave feedback concerning the importance of good network reception and ease of use of MMS for successful use of the mediaBoard.

The following is an example of a mediaBoard created by a tutor for an elementary course in English as a Foreign Language (EFL). Fourteen students used the board, working in pairs, as an orientation exercise to the local area. Afterwards the tutor stated that the students "*loved getting out of the classroom and using information and learning technology".*

4 The challenges in setting up a mobile learning project

The partners experienced a number of challenges in setting up and running this project which it may be useful to describe in order to inform the work of others contemplating mobile learning projects. These challenges concerned:

- Sourcing the devices to be used
- Deciding on the most appropriate charging tariff
- Deciding who should pay for chargeable services (eg for sending text messages)
- Setting up effective support, communications and information exchanging channels with tutors, many of whom work on a part-time basis
- Installing software in colleges and liaising with technical gatekeepers

The lessons we have learned in the context of these challenges are discussed in the next section.

5 Lessons learned

5.1 Unlocking the mobile devices and obtaining system settings from network operators

The devices (XDAIIs) used for this project were originally bought for use in the m-learning project. For the toolkit project they needed to be unlocked from their previous service provider, O_2 in order to allow them to used on other networks. This was found to be difficult for the staff involved, who did not have significant technical expertise. Advice was sought from the network operators who were generally found to be unhelpful or who stated they did not support the devices. Eventually the problems were solved with the advice from the XDA developers' forum[2].

[2] http://forum.xda-developers.com/viewtopic.php?t=24779

After the devices had been unlocked, each network operator (this study used four different providers, which tutors recommended as providing the best service in the different areas where the tutors were located) required different settings to be entered in the PDAs to ensure that they worked with their particular communications systems. These proved difficult to obtain because a) most calls to network operators are taken initially by call centre personnel who are not necessarily familiar with the devices and were found only to be able to answer simple, routine questions; and b) it is difficult to contact technicians directly, and some technicians are reluctant to help when the PDAs being used are not usually supported by their organisations.

5.2 Deciding on charging tariffs

Because the research period was shorter than the standard contract terms offered by network operators, and in order to control costs, the use of top-up cards with pre-paid SIM cards was chosen, rather than a contract. As four different network operators were involved, it was a lengthy process to acquire the cards (some shops were reluctant to supply more than a couple of top-up cards) and link the top-up cards to the SIM cards and place credit on the PDAs.

5.3 MMS problems

Unexpectedly, the decision to use pre-paid SIM cards had a negative effect on the project and, particularly, on the use of the mediaBoard. It was discovered that some network operators provide an inferior service to customers who use the pre-paid service compared to those using the service on a contract basis, particularly regarding MMS. Many of the MMS messages sent during the project never arrived and when the network providers were contacted they were often unable to explain why this was so, or to provide assistance. The importance of reliable network support for mobile learning involving the use of MMS cannot be overstated. Therefore we would recommend that other projects considering the use of MMS do not use pre-paid services.

5.4 Deciding who should pay for chargeable services

It was expected that the students taking part in the SMS quiz and mediaBoard activities would use their own mobile phones. In some cases students told their tutors that they were happy to incur the cost of a few calls in order to take part. However, other tutors reported that many of their learners often had no credit available on their mobiles. The project partners and tutor co-ordinators discussed a number of options for reimbursing these students. Eventually it was decided that each tutor should discuss this matter with their students and decide the most acceptable solution for each group. The tutors would them implement this solution and the cost of this would be reimbursed by LSDA. At the end of the project, nine tutors stated their learners used their own mobile devices, and examples of reimbursement included £1 Boots vouchers and McFlurry™ ice creams.

5.5 Setting up effective communications and support

Setting up effective communications and information exchange channels was a challenge. Support for the tutors was available by telephone, e-mail and mobile phone, and through the project's extranet. Almost all the support required by the tutors was found to be technical and supporting them was time-consuming. It was also often difficult to contact tutors in order to discuss or respond to their problems. Communication difficulties were a result of:

- tutors not having ready access to a landline telephone
- tutors having difficulty using the PDA as a mobile phone (eg network reception when tutors were not located at the college)
- lack of easy access to a computer (for e-mail)
- heavy teaching commitments
- difficulties contacting part-time tutors as they were only available on certain days

Any institution planning to introduce, or trial, mobile learning, needs to ensure they make adequate provision for technical support which is driven by the needs of the users and takes into account their work patterns and working locations.

5.6 College ICT facilities and technical gatekeepers

At the beginning of the project a number of software applications needed to be installed on the tutors' PCs, ie the MyLearning games software, ActiveSync and Flash. This was found problematic in most of the colleges, as the IT departments do not allow tutors to install software packages themselves. Many tutors experienced frustration due to having to wait for technicians to load programs on their behalf, sometimes only on one PC at a time, one package at a time. Some tutors circumvented these difficulties by sharing computers or by using their home computers, or laptops, which were not firewall protected. These delays reduced the amount of time available for tutors to use the toolkit. When planning a mobile learning project in a college, we recommend early discussions with, and involvement of, the IT support staff in order to avoid problems during implementation.

Also, it is recommended that tutors planning mobile learning activities check beforehand with their institutions that there are no restrictions on the use of mobile phones. During this research some tutors had planned to provide mobile phone based career-choice activities for visiting schoolchildren. However on the day of the visit they discovered that the children had not been allowed to bring their mobile phones with them. Thus, mobile learning initiatives can be easily derailed by local restrictions and the attitudes of institutional management if there has been insufficient consultation.

6 Conclusions

This project offered tutors based in five further education colleges the opportunity to create mobile learning materials for their students, catering for their specific needs in their particular context. Tutors found it easy to integrate the use of the toolkit, learning materials and activities into lessons and almost all of the tutors were keen to

continue using the toolkit with their students in the future. This project has also highlighted some of the challenges researchers and tutors face with mobile learning projects and identified some lessons learned which could be useful to others considering undertaking mobile learning activities in the future.

7 References

Attewell, J (2005) Mobile Technologies and learning – a technology update and m-learning project summary. Learning and Skills Development Agency. London, UK (https://www.lsneducation.org.uk/user/order.aspx?code=041923&src=XOWEB&cookie_test=true, accessed on 15 November 2006)

Savill-Smith, C. A., Attewell, J., & Stead, G. (2006 (forthcoming)). Mobile learning in practice – piloting a mobile learning teachers' toolkit in further education colleges. Learning and Skills Network. London, UK.

Running head: CORPORATE VIEW

A Corporate View of Mobile Learning

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Abstract

In the corporate training environment, acquisition of new skills by employees through training is critically important. This obviously implies that practice-based training programs that enable employees to internalize, and, more importantly, experience, new skills by doing have a significant impact on getting employees started quickly. This paper looks into the opportunity that is presented by mobile devices to deliver on-the-spot (OTS) practice that interlaces guidance with the do-it-yourself experience, particularly for the non-office based distributed workforce. Further, the paper deals with instructional constructs that enrich audio-based mobile learning. These instructional constructs are an attempt to deliver effective and enriching learning experience through short duration mobile lessons and leverage podcasting capabilities for the development of episodic learning.

A Corporate View of Mobile Learning

Introduction

With the marketplace becoming increasingly competitive, corporations are looking at learning as a strategic support function with the objective of aligning their competitive advantages with their business initiatives. However, the achievement of the strategic intent behind learning is critically dependent upon adoption, or the acceptability of the learning program by the desired audience . Therefore, the role of the learning function and the acceptance of learning programs are central to businesses driven by hypercompetition.

However, the very hypercompetition that makes organizational learning imperative is also demanding on the time of working professionals. Not surprisingly therefore, the sheer lack of time on the part of employees, notwithstanding the motivation to learn or organizational appreciation of the desirability of learning programs, is often the cause of low adoption of learning programs and this proves to be the stumbling block in making organizational learning happen.

Corporate Reality

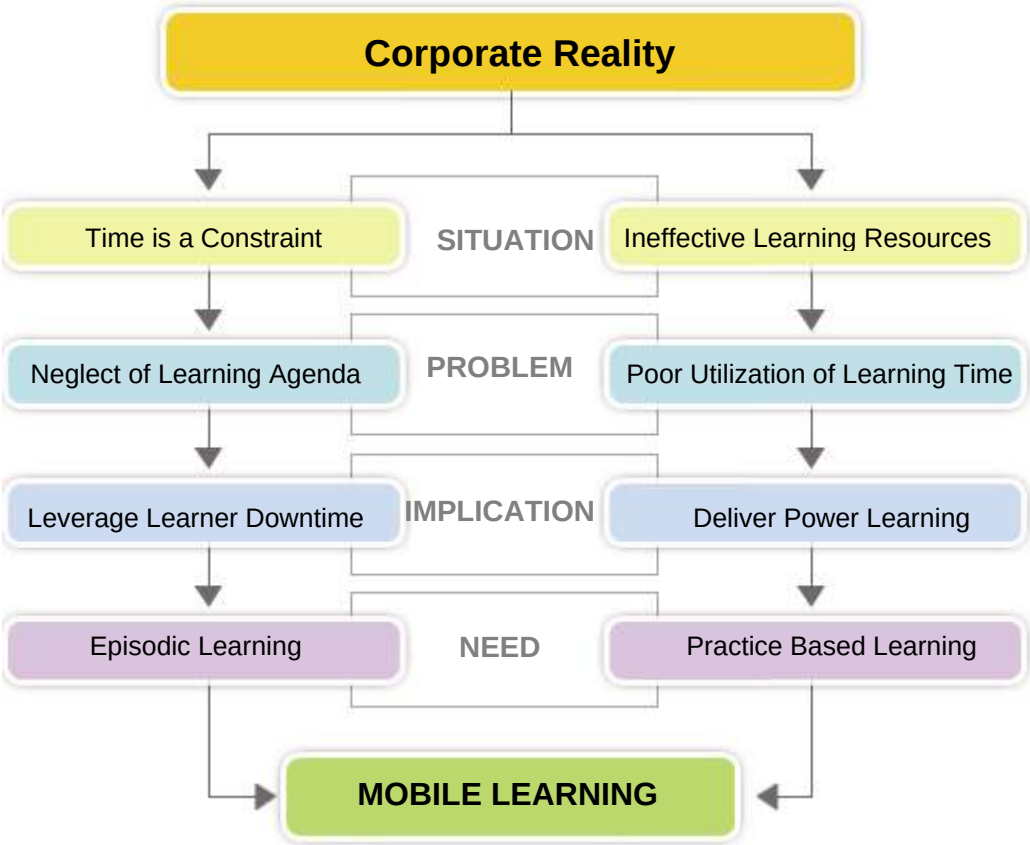

Figure 1

Research indicates that time deprivation is a major bottleneck in realizing meaningful learning intervention. Whether at work or outside, the working professional typically has little time to spare. As a result, the need to learn, inadvertently and unfortunately, takes a backseat. For example, a training program that requires the learner to take out 30-odd minutes may not necessarily fit in the learner's schedule because of the time crunch, both in and out of office. Therefore, a training program, howsoever well intended, instructionally sound, and critically required to plug a competency gap, will fall short of the desired adoption metric.

Direct fallout from the lack of time is the neglect of Personal Learning Agenda (PLA) by time-strapped professionals in the corporate environment. As distinct from organizational

predisposition in the professional learning agenda of a person, the PLA of the person typically relates to acquisition of knowledge and skills residing outside the organizational, work-related domain. For example, the PLA of a person can range from learning a new language to mastering stock market tips and tricks to become a smart investor.

However, the distinction between personal and professional learning agendas does not deny the possibility of overlaps between the two agendas. For example, though the need to learn a new language may figure on the PLA of a working professional, the beneficiary of the learning can also be the employing organization. Benefits accruing from the PLA of a professional to the organization may or may not be immediately apparent, but there is no denying the possibility that certain PLA element of a professional can be as much part of the organizational learning agenda. Therefore, it is important for corporations to take a holistic view of the learning agendas of their professionals.

But, notwithstanding the professional or personal nature of a learning agenda, the possible overlap between the two agendas, and the organizational commitment to a holistic view of learning, the crux of the problem is that the hectic schedules of professionals leave them with little time to pursue their learning agendas.

Therefore, corporations cognizant of the learning agendas of their employees and sensitive to the issue of time deprivation should leverage the ubiquity of mobile phones for providing access to learning-ware during the periods of time when their professionals are not gainfully engaged, or learner downtime. For example, home-office commute or office-client site commute time typically goes underutilized because there is no access to learning material on the go. But, if mobile access to learning resources can be enabled during such times, employees will be able to plug such “holes in time” with short bursts of episodic learning.

Along with time deprivation, time-to-competency of new hires and people moving to new roles is another critical issue in the corporate learning environment. While managers do not doubt the role of training in getting employees started, their belief that the actual learning happens on-the-job belies their confidence in learning resources. In a way, this underlines the inadequacies in the current learning resources, which, in turn, result in poor returns on the learning time. Such sub-optimal transference of knowledge and skills manifests in a low throughput at the workplace. Therefore, with the intent of achieving efficient internalization of knowledge and skills, corporations are focusing on practice-based power learning.

Further, with the intent of optimizing the transference of knowledge and skills to corporate learners, it is equally important to understand the predominant learning style in the corporate environment and seek opportunities to use that learning style to propagate learning. In this context, it is important to analyze David Kolb's Learning Styles Inventory (LSI).

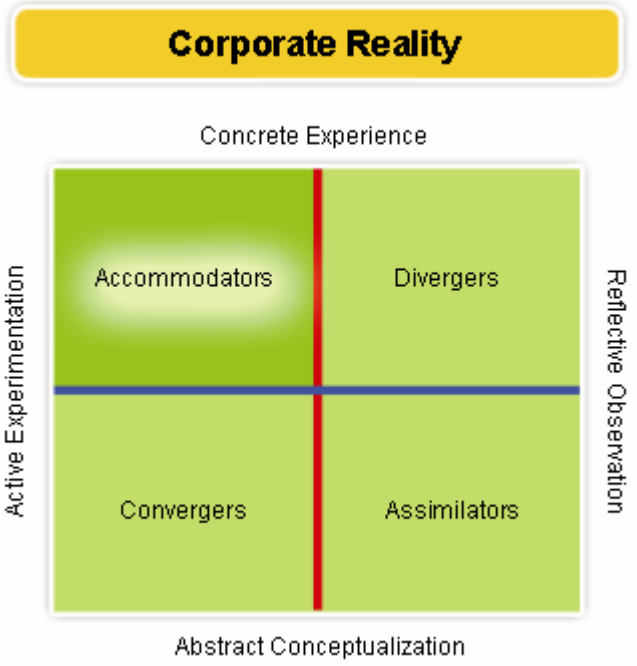

Figure 2

Researches indicate that computer-based learning is relatively more effective with the learning style of Convergers, who occupy the Abstract Conceptualization – Active Experimentation quadrant. In this context, it is important to note that managers, with their pronounced hands-on approach to learning, typically reside in the accommodators' quadrant.

The fact that the Concrete Experience and Active Experimentation axes form the accommodators' quadrant suggests a strong bias in favor of practical, active learning by managers. By extending the learning-by-doing paradigm, it is reasonable to conclude that managers prefer working with real objects and situations, and therefore, the ubiquity and portability of mobile devices can be leveraged to deliver power learning that is practical and on the spot, allowing corporate managers the opportunity to learn by manipulating real objects.

Power learning and episodic learning

Before delving into the role of mobile devices in delivering practice-based power learning in corporations, it is important to look at the way practice is enabled in other forms of learning interventions. In the eLearning model, typically simulations are favored to provide learners with the opportunity to apply their learning. In this model, the advantage for the learner is the guidance that accompanies every step. However, the downside of a simulation-based practice is the lack of opportunity to practice on real life objects or in real life situations. It is important to appreciate the simulation-real life disconnect because objects or situations may be very different outside of a simulated environment. Not surprisingly, therefore, the focus of problem-based learning is to build problem-solving capabilities because problems rarely replicate in real life as visualized in the courseware.

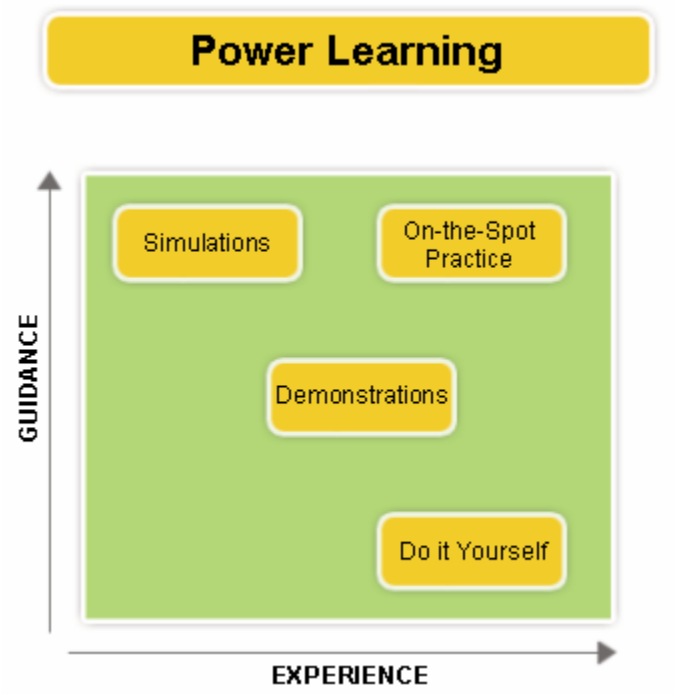

Figure 3

At the other end of the practice spectrum is the Do-it-Yourself (DIY) model where learners actually learn through practice on real life objects, or in real life situations. The advantage of the DIY model of course is the opportunity to practice on real objects; there is no simulation of the actual object. But the flipside of the DIY model is the loss of guidance that the eLearning model offers.

Therefore, the critical issue in delivering power learning is the integration of guided practice into live situations, particularly in the case of non-office based mobile workers such as field technicians, and enabling the transfer of skills being learned to contexts that learners can appreciate. In this context, the ubiquitous mobile device can be leveraged to deliver practice-based power learning, which is interlaced with guidance, on the spot.

From this, it emerges that On-the-Spot (OTS) is an important mobile learning instructional construct that corporations can employ to develop and deliver training to their managers and in-field employees. The advantage it offers upfront is that the OTS instructional

paradigm fits the learning-by-doing model typically favored by managers. Next, mobile devices enabled OTS instructional model has the potential to bridge the learner-practitioner divide because employees will learn by being hands-on with real tasks. Further, the transfer of skill is likely to be more efficient because the DIY experience can be tightly coupled with guidance.

In addition to OTS learning, mobile devices are obviously well suited to enable on-the-move access to learning resources, which will help working professionals to plug “holes in time” with learning. But the more important thing here is that the design of learning resources intended for use on the go must be informed by considerations that facilitate episodic, intermittent learning. For example, an important design consideration is that a learning module that is designed for mobile access must be short enough to plug “holes in time.” Then, learning resources intended for use on the move should be designed to handle distractions and interruptions and should enable multitasking, or pursuit of learning along with performance of regular routine tasks. In fact, with learning-ware designed for multitasking, working professionals will find the much-needed time to pursue their learning agendas without interfering with their daily schedules.

Based on the multitasking requirement of mobile courseware users, an important design consideration is hands-free, auditory interface with learning resources for which the audio capability of mobile devices can be exploited. However, there are certain challenges in audio learning.

For example, compared to reading, which happens in blocks, audio learning is time bound because the time that is needed to go through an audio course is defined by the duration of the audio file. For example, a 10-minute mobile lesson will require 10 minutes of the learner’s time to complete the lesson. Secondly, navigation is an issue with audio learning because it is

typically designed for linear perusal. In comparison to reading, where readers can intelligently skip, non-linear navigation through an audio file is relatively less intuitive. Thirdly, looking for particular information in an audio file is cumbersome and, therefore, audio courses have inefficient, or rather no, recall mechanisms.

Instructional constructs

The mobile learning instructional constructs address the challenges in delivering engaging auditory learning within short spans, and tackle issues such as inefficient recall capability. For example, the audio summary instructional construct addresses the issue of poor recall mechanisms in audio courses and this is a handy post-instructional memory aid. Some other useful auditory instructional constructs that enable engaging mobile learning are:

- Multimedia – Uses sound effects, rhyme, images, music to deliver enriched audio learning
- Enacted examples: Leverages the potential of audio drama to deliver scenario based learning
- On – the – Spot: Blends the advantage of guided simulations with the do-it-yourself experience
- Thin slicing: Juxtaposes snapshots of a multifaceted concept to give a peek at the expanse of the concept
- Print-n-Learn: Interlaces audio courses with print artifacts such as engineering diagrams and graphs
- Job Jackets – Provides opportunity to tag context for increased contextualization
- Audio Summary - Addresses post-instructional retention needs of learners
- Interview: Enables informal learning with radio-style talk shows with experts

- Case Story - Illustrates a learning goal by using real life examples or scenarios
- Reflection Questions – Triggers out-of-the-box thinking and application of learning

The linear delivery of a typical audio course and the short duration of a mobile lesson underline the need for instructional constructs that facilitate effective learning in short modules, attempt to compensate for the absence the instructor in the online medium, and peg mobile learning a few notches above plain podcasts.

Conclusion

In a business environment, mobile learning occupies a unique place because it empowers corporations to reach out to its employees unobtrusively by interweaving learning with other everyday activities. Further, it has an important role to play in realizing a seamless, pervasive corporate learning environment that can go a long way in facilitating participation of working professionals in the learning process.

References

Boyatzis Richard E (2001). Unleashing the Power of Self-Directed Learning. Eiconsortium. From http://www.eiconsortium.org/research/self-directed_learning.htm, accessed November 2006

Bersin Josh (2006). A New Approach: High Impact Training Measurement. Bersin & Associates. From http://www.bersin.com/tips_techniques/06_oct_meas.asp, accessed November 2006

Keegan Desmond (2004). Devices and Technologies for Mobile Learning

The New Media Consortium and the Educause Learning Initiative (2006). The 2006 Horizon Report

The eLearning Guild Research (2006). Future Directions in eLearning Research Report 2006

Kolb Alice Y and Kolb David A (2005). The Kolb Learning Style Inventory – Version 3.1 2005 Technical Specifications

Knowledge Anywhere (2002). Flexible Learning: Mobile Learning Objects

Prensky M (2005). What Can You Learn from a Cell Phone? Almost Anything!. From http://www.pjb.co.uk/m-learning/articles.htm, accessed October 2005

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Figure Captions

Figure 1. Challenges in the Corporate Learning Environment

Figure 2. Kolb's Learning Styles

Figure 3. On-the-Spot Practice-based Learning

THE PLACE AND ROLE OF EM-LEARNING IN MULTI-MODE DELIVERY OF EDUCATOR TRAINING IN SOUTH AFRICA

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1 INTRODUCTION

In any country in the world, the business and responsibility of, as well as the challenge to the education fraternity are to provide quality education to all. Therefore, quality teaching and learning should be provided to assist all learners to acquire the required competencies (knowledge, skills and attitudes) at the highest possible level in order to fulfil their respective and diverse roles in life (Steyn, Steyn, De Waal and Wolhuter, 2002: 34). The point of departure should be to provide quality education in such a way that it is accessible and affordable to all. The quality of education is to a large extent determined by the quality of information transfer and the quality and quantity of support that the learners receive to master the outcomes of their studies. The developments in the field of Information and Communication Technology (ICT) provide a real opportunity to improve the quality of information transfer and teaching support that learners can obtain. However, the real challenge for education in the developing world, and even in the developed world, is the level of accessibility, affordability and complexities of ICT (Dreyer, 2005: 4). The result of the ability to provide assessable ICT in developing countries is the ever-increasing digital gap that deeply influences the quality of education of less affluent people and the difference in quality of education between developed and developing countries.

At the North-West University, Faculty of Education Sciences, the decision was made to provide enriched teaching and learning to a particular group of teachers via an off-campus blended teaching and learning strategy. Within the limitations of affordability and access, the decision was made to use the multi-mode teaching strategy (including some types of modern ICT) to support the students and to enhance the support that the learners obtain. The aim of this article is to report on the reasons, development and implementation of the project as well as initial results. Attention will be given to the nature and contents of the ADP-programme, the theoretical framework that was used to

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develop the strategy and the nature and content of the multi-mode teaching strategy that was employed.

The method of research that was used to develop the teaching and learning strategy particularly applicable to this programme was that of a process of iterative and systematic critical reasoning. Based on the critical reasoning, it was through an combined (and not necessarily initially decided upon) application of several (applicable) scientific methods and processes, such as observation, analysis and synthesis, induction and deduction that the strategy was developed (Stoker, 1961: 62-90; Mouton and Marais, 1989: 102; Mouton, 1996; 77-78; Harden and Thomas, 2005: 258; Bensley, 1998: 3; Ennis, 1987: 9).

2 THE AFRICAN DRIVE PROJECT (ADP) FOR ENRICHED TEACHER EDUCATION IN THE RURAL AREAS

The ADP is a joint venture between the Department of Education (North-West Province, South Africa), the North-West University (Faculty of Education Sciences, Potchefstroom, South Africa), eDegree (a private company assisting education institutions to provide e-learning programmes), GTZ (the German Technical Corporation), SAP (Software Applications and Products: a private company with the aim of developing e-learning via the Internet in South Africa) and Duxbury Appliances as main partners. These partners made a joint decision to test the feasibility of the application of e-learning for the in-service education of practising teachers in the North-West Province (ADP, 2004).

This programme was launched in order to address the following challenges in South African education and particularly the North-West Province, namely:

- the serious shortage of suitably qualified primary and secondary school educators;
- a major shortage of suitably qualified graduates to participate in the technology orientated local and global economy; and
- the realisation that special attention will need to be given to the compelling evidence that the country has a critical shortage of mathematics, science and language teachers and to the demands of the new information and communication technologies.

The focus of the ADP-programme is to:

- emphasise secondary (Gr. 10-12) educator development;
- develop innovative new learner-centred learning programmes and strategies;
- utilise appropriate information and communication technologies, to ensure:

    - increased access,
    - improved delivery, and
    - effective management of teaching and learning;
- develop and evaluate appropriate models for the provision of Mathematics, Physical Science, Technology, Entrepreneurship, functional English and HIV/AIDS education and training to in-service educators in the North-West Province, South Africa and Africa by using:
    - a blended learning model for relevant learning,
    - an appropriate technology model for scalability, and
    - an attainable cost model for sustainability;
- facilitate the introduction of ICT into the delivery of learning at schools;
- facilitate the rollout of blended learning to educators and learners in the North-West Provinces, South Africa, SADC and Africa; and
- informs Government policies and strategies on educator development (provincially, nationally, SADC and in Africa).

The programme selected was the Advanced Certificate in Education (Natural Sciences and Mathematics). The modules of the programme may be summarised as follows:

YEAR 1			YEAR 2		
Code	**Module**	**Cr**	**Code**	**Module**	**Cr**
ORLK 511	Teaching and Learning A	8	ORLK 521	Teaching and Learning B	8
GSTK 511	Foundation studies in education and teaching	8			
RIDO 525	Computer principles in Education	8			
End July 2006			**End June 2007**		
Mathematics			**Science**		
NWSK 513	Mathematics for ACE IA	16	NCHK 511	Matter and stoichiometry for science education	16
NWSK 514	Mathematics for ACE IB	16	NFSK 511	Electricity for science education	16
End November 2006			**End June 2007**		

The major characteristic of the development of the course is the fact that e-teaching and learning plays a pivotal role in the delivery of the programme. Therefore, due to the fact that e-technology is not readily available in the rural areas, eight learning centres were developed, namely at Mafikeng (NWU), Mankwe, Taung, Kuruman, Rustenburg, Vaal Reefs, Bakwena and Baitsoki.

The overall control of the project is the responsibility of the ADP-Trust; the actual responsibility to deliver the programme is that of the Faculty of Education Sciences, supported by eDegree. The responsibility to develop the relevant technologies is that of SAP, and the North-West Department of Education is responsible for equipping the facilitation centres and identifying and supporting the relevant teachers, namely the students of the programme.

3 TEACHING AND LEARNING STRATEGY FOR THE ACE IN THE AFRICAN-DRIVE PROGRAMME

3.1 EDUCATION

Education refers to the planned activities of educators to assist learners to acquire/learn the relevant competencies (knowledge, skills and attitudes/values) in order to execute the learners' roles in life (Steyn, Steyn, De Waal and Wolhuter, 2002: 34).

Therefore, the focus of the programme is to provide the learners with sufficient learning opportunities to acquire the agreed-upon competencies. The learners must choose and use the relevant available support mechanisms in order to learn and acquire the competencies. The programme strives to assist and promote the development of self-directed, responsible learners. Therefore, the programme will not support a pursuit of qualifications or spoon feeding.

3.2 OUTCOMES-BASED EDUCATION

The teaching and learning strategy is informed by the principles of outcomes-based education. According to these principles, the teaching and learning activities as well as the content and assessment should be directed at the needs and requirements of the educators. The outcomes should directly relate to the competencies required by the practising teachers. Teaching and learning should also be informed by the constructivist approach according to which the context of learning is important, and teaching should be directed at assisting learners in developing the relevant concepts according to their own interests, aptitudes and abilities. The programme strives to support individualisation in teaching and learning (Ram, 1996: 89; Ertmer and Newby, 1996: 1-24).

3.3 EM-LEARNING (electronic-mobile learning)

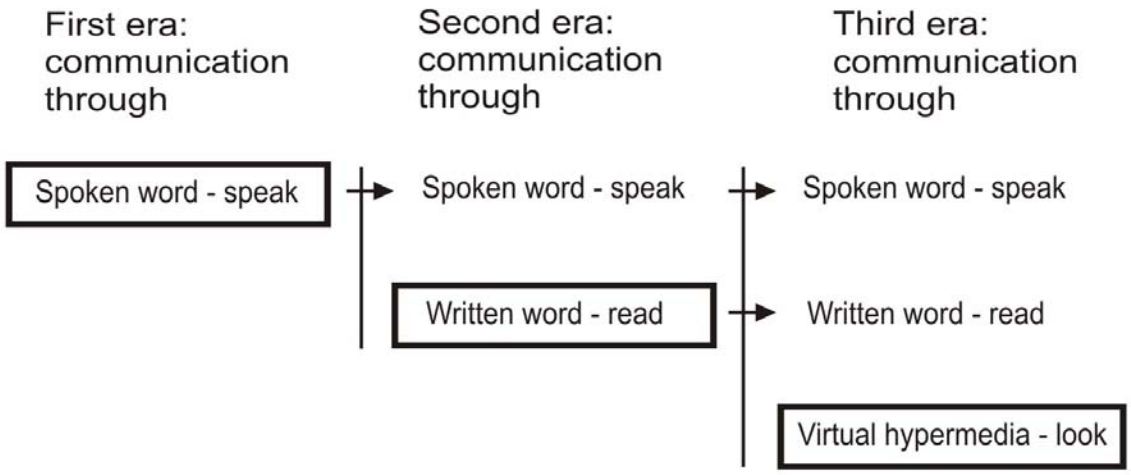
3.3.1 Education and the provision of information

The place of e-learning should be understood within the context of the provision of information and contact (guidance/support) to students. Subsequently, the importance of the hypermedia image becomes evident.

It is also clear that dramatic developments have occurred in this field. 'Traditional text forms typically include a combination of two types of media: print and two-dimensional graphics. Electronic texts can integrate a range of symbols and multiple-media formats including icons, animated symbols, photographs, cartoons, advertisements, audio and video clips, virtual reality environments and new forms of information with non-traditional combinations of font size and colour' (Brunner and Tally, 1999).

The history of civilization and the relationship with developments in communication can be presented as follows:

Fig 1 History of civilization and communication (Rossouw, 2004)



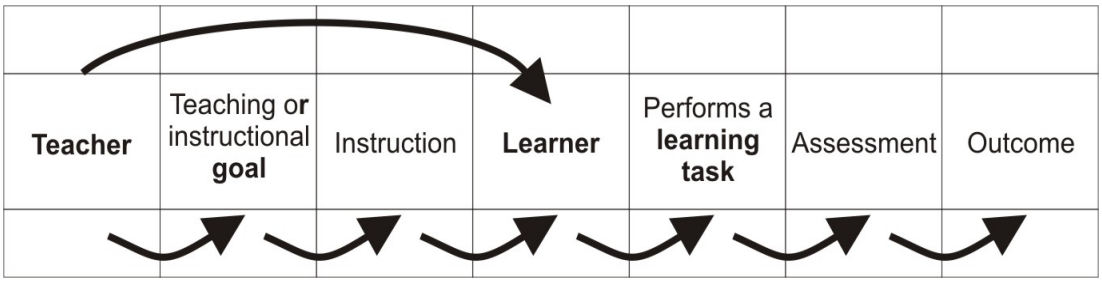
Communication is important in education. Therefore, the same periods may be distinguished in the history of education. However, hypermedia is not used in education. This aspect limits effective education and should be corrected as soon as possible.

3.3.2 Education/teaching and learning

❒ **The traditional teaching-learning situation**

In the traditional teaching-learning situation, teaching and learning occur linearly (see Figure 1).

Fig. 1 The traditional teaching-learning situation (Monteith and Dreyer, 2005)



The teacher decides on a teaching or learning goal and, for example, instructs a class of learners to attain the **same** goal in the **same** way, using the **same** method(s) to attain the **same** outcomes. In this process, a task has to be completed, which is then assessed. **All** the **learners** have to complete the task in the **same** way, using the **same** methods to attain the **same** outcomes. Learners do not have much freedom in the choice of tasks, methods and the outcomes they would like to attain. Interaction is poor, and mainly one-to-one (one teacher, one learner, one source, one way, etc.)

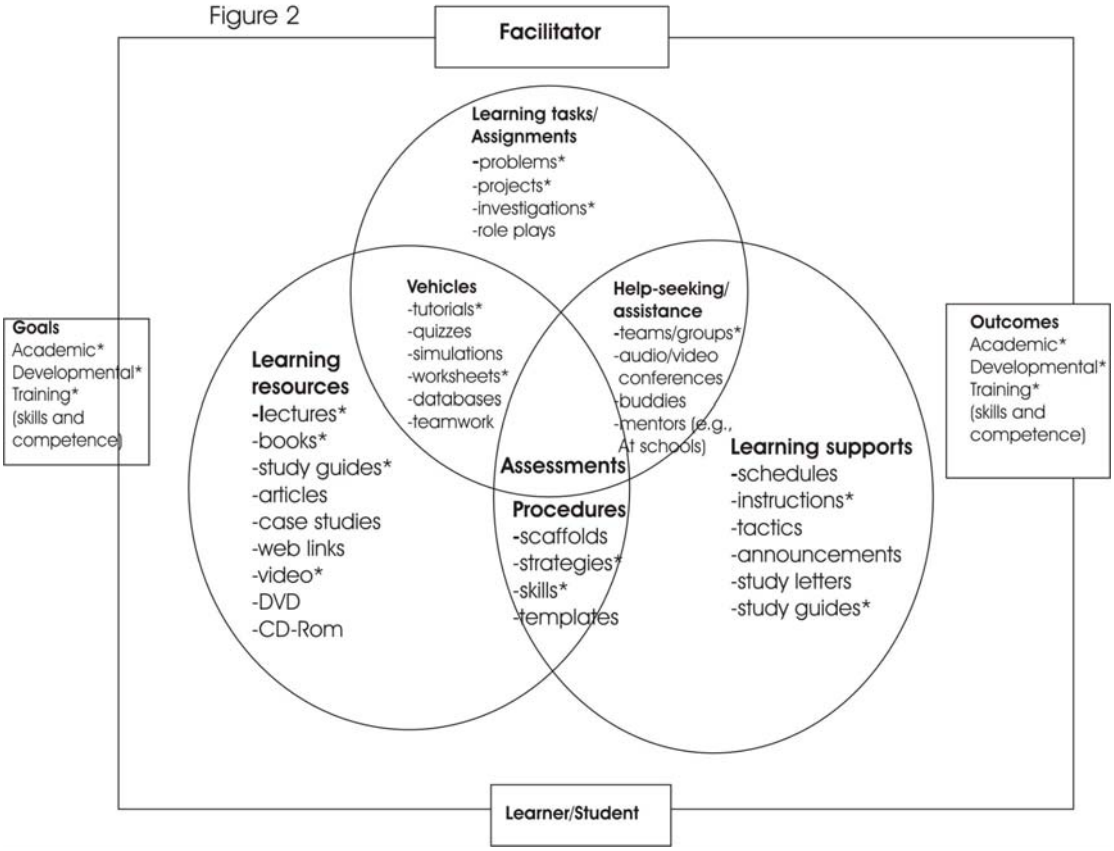
❒ **Teaching and learning in the 21st century**

Teaching and learning should take place within a learning community that functions non-linearly (see Figure 2 by Monteith and Dreyer, 2005). Structurally, the learning

community is an extension of the physical community outward to the electronic community. The extension, however, is not linear; rather, it is multidimensional and multilayered. The learning process in the community becomes like following a map, a kind of self-directed journey that the learner is embarking on with the help of a guide and (sometimes) a compass (Help-seeking/Assistance). Instead of exclusive teacher delivery, instruction is provided by a multitude of 'sources'. Assessment is assumed to be inherent in the performance of the learner in obtaining his/her goals. When designing learning experiences for students in the 21st century, three key elements should be emphasised: the content or resources learners interact with, the tasks or activities learners are required to perform, and the support mechanisms provided to assist learners to engage with the tasks and resources. Interaction is rich, multidimensional and non-linear (mutual between teacher, learner, groups, resources, by means of different vehicles, etc.) (Monteith and Dreyer, 2005.)

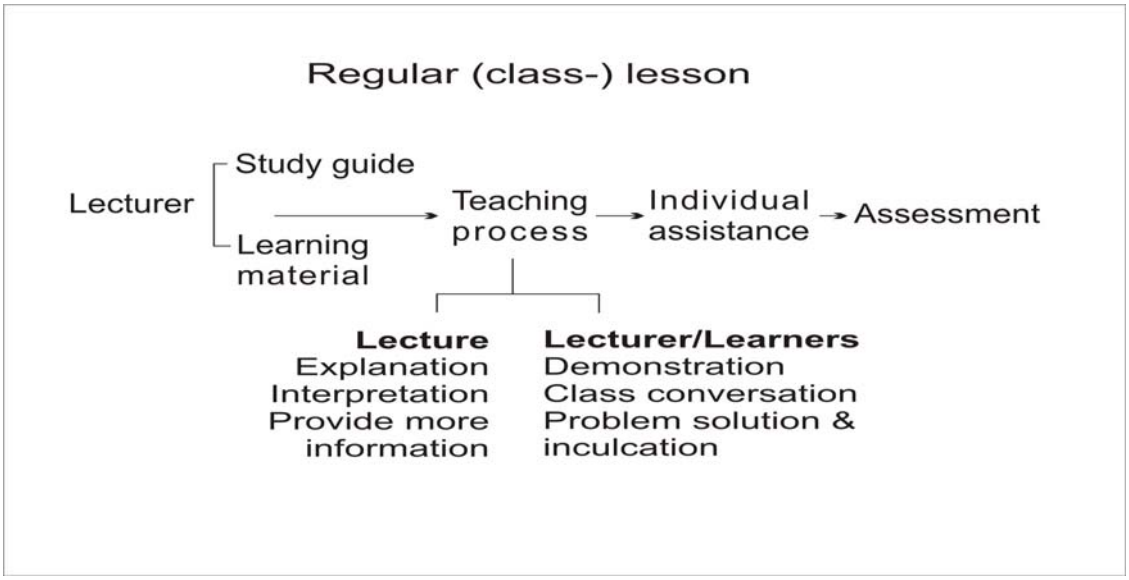
Learning community

Figure 2



❒ Contact education

In South Africa, 'pure' contact teaching is presently used as the benchmark against which the effectiveness of education is measured. Contact education can be illustrated as follows:



Within the em-learning context, all typical aspects of traditional contact teaching can and should be provided, using different techniques/methods. In changing the support structure for teaching and learning in a developing country, it is important that the change which is effectuated is not too dramatic. Therefore, it is necessary to try and retain the familiar way of support for effective teaching and learning and gradually introduce the new types of em-teaching support.

In a developing country such as South Africa, em-learning should also be adapted according to the availability of electronic and other infrastructure.

4 BLENDED MODEL FOR TEACHING AND LEARNING

The blended model refers to a context within which different techniques/methods of teaching are provided, integrated in such a (logical) manner that it can be used by the individual learner according to the learner's specific situation and preferences. Blended teaching refers to the thoughtful integration of different teaching strategies, such as face-to-face teaching and the different online techniques, employing the strengths of each. Blended learning is about rethinking and reengineering the teaching and learning relationship (Garrison and Kanuka, 2004: 96; Osguthorpe and Graham, 2003: 227). The blended teaching and learning environment provides a number of advantages (Miller and Padgett, 1998; Dreyer, 2005):

- Students are able to access a variety of resources in a flexible manner.
- The blended teaching support ensures that the risks and benefits of synchronous and asynchronous support are spread and that support is always available.
- The format provides for flexibility concerning time and distance.
- The blended format takes students' familiarity with technology into consideration.

- The students are expected of to take more control over their studies.

5 TECHNIQUES/METHODS OF TEACHING TO BE USED IN THE ACE (OF THE ADP)

The challenge is to provide a blended model of teaching strategy to students living in the North-West Province, which is primarily a rural area, and to try and retain the principles of accessibility, affordability and enrichment. The primary challenge is to provide em-teaching and learning opportunities to students in rural areas. Based on the above-mentioned theoretical points of departure the multi-mode strategy of teaching was developed. The decision was taken to employ different techniques/methods of teaching as multi-mode strategy of teaching, ranging from the commonly used paper-based material and face-to-face support to electronic support on the web, in order to support the learners in achieving the required outcomes (Faculty of Education Sciences, 2006). By developing this particular strategy, the known type of support was retained, namely the paper-based material and the face-to-face meetings and the changes was not experienced as really big and frightening by the learners. The sms and DBD were employed because almost all learners are in possession of a cellphone and have direct access to a television and DVD-player. To introduce the internet support the eight learning centres were provided. The support techniques can be explained as follows:

- **Paper-based learning content**

Paper-based material includes the study guide, which serves as a roadmap that guides the study, as well as paper-based learning material that learners should employ to obtain the basic information required to reach the agreed-upon competencies. In a developing country, paper-based material ensures continuous accessibility of learning material because learners cannot primarily depend upon e-material, due to, for example, the problems regarding connectivity to the Internet.

- **DBD (digital book disk)**

The DBD can be described as the e-book in DVD-format, thus the paper-back format of the e-book. The DBD includes the integration of the written word, spoken word and hypermedia images. The DBD consists of the summary of the paper-based material as backbone and which is enriched with material from the videosphere, such as photos, animations, and teaching, as well as teaching videos. Each of the modules should have at least one accompanying DBD.

- **Contact sessions**

A limited number of contact sessions are provided to enable direct contact between the lecturer and student. The nature and content of these contact sessions should focus on the aspects of problem-solving and reinforcement of the level at which the learners should reach the agreed-upon competencies.

- **Cellular phone/sms contact**

The purpose of sms is to effectuate continuous contact with the students. The main aim of a sms should be to provide information, such as reminders and small pieces of guidance, regarding the particular module. At least one sms should be sent per week for each module.

- **E-mail**

E-mail is an additional method of personalised contact with the students. E-mails should be used to provide more extensive continuous information and guidance to the learners, and can be regarded as an extension of the sms. In addition, e-mail serves as a method for students to become accustomed to the use of electronic media. At least one e-mail should be sent to students per module every fortnight.

- **The web**

Web pages should be used to provide up-to-date (longer) information or learning material and bits of real (video) communications to students. Relevant information may be downloaded from the web and made available to students, or the students may find the information on the web themselves, e.g. an article in a daily paper. The (approximately) 5-minute lecturer videos should, for example, be used by the lecturer to provide up-to-date information, explain more fully by using present day situations or to provide information about particular problems in a particular assignment. The information and videos should be made available on the web at least every fortnight. At least one discussion forum should be provided per module per semester, and at least two (easy) assessment exercises per semester per module.

Results

The preliminary results of the implementation of the decided upon multi-mode teaching and learning strategy are very positive. The students fully benefited from the familiar paper-based and face-to-face support, appreciated the sms-support and gradually became accustomed to the use of the DBD, e-mail and web-support. One of the main stumbling blocks is the level at which Internet connectivity is achieved at the different centres. The students could not regularly connect to the Internet in order to access the new information and to submit their assignments, seeing that the Internet connections

were dysfunctional. Currently, an attempt is being made to provide the rural centres with wireless connectivity and, in this sense, to try and solve the connectivity problem.

6 SUMMARY

This article provided a report on the way in which the Faculty of Education Sciences endeavoured to enrich the quality of distance education by enhancing it through electronic-mobile support of practising teachers in their in-service and training programmes. By means of the partnership between the North-West University, the North-West Department of Education and the private sector, the nature of the programme was explained. The theory on which the electronic-mobile support of students was constructed was elucidated, and the constituents of the multi-mode strategy of supporting students were explained and preliminary results provided.

The final conclusion is that the strategy holds well for the enriched support of students in distance education, and shortcomings should be addressed in order to maximise the success of the multi-mode support of students.

SOURCES

ADP(TRUST), 2004. *African Drive Project*. Johannesburg: SAP.

Bensley, DA. 1998. *Critical Thinking In Psychology*. Pacific Grove: Brooks/Cole Publishing Company.

Dreyer, C. *Designing Blended Electronic-Mobile Learning Environments For Teacher Training In Developing Countries*. Potchefstroom: NWU.

Dreyer, C. 2005. *Attacking The Digital Divide – Designing Electronic-Mobile Learning Environments For Improved Teacher Training In Developing Countries: Paper presented at the International Congress for School Effectiveness and Improvement, 2-5 January, Barcelona, Spain.*

Ennis, RH. 1987. A Tsonomy Of Critical Thinking Dispositions And Abilities. In *Teaching Thinking Skills: Theory And Practice*. Baron, J & Sternberg, R. New York: WH Freeman.

ERTMER, P.A. & NEWBY, T.J. 1996. The Expert Learner – Strategic, Self-Regulated, And Reflective. *Instructional Science,* 24:1-14.

Garrison, DR & Kanuka, H. 2004. Blended Learning – Uncovering Its Transformative Potential In Higher Education. *The Internet and Higher Education*, 7(2): 95-105.

Faculty of Education Sciences. 2006. *Teaching And Learning Strategy For The ACE In The African Drive Programme*. Potchefstroom: North-West University (Faculty of Education Sciences).

Miller, MD & Padgett, TC 1998. Redesigning The Learning Environment For Distance Education – An Integrative Model Of Technologically Supported Learning Environments. *Online Journal Of Distance Learning Administration*, 1(1). In *Designing Blended Electronic-Mobile Learning Environments For Teacher Training In Developing Countries*. Dreyer, C. Potchefstroom: NWU.

Monteith, JL de K & Dreyer, C. 2005. *Some Features Of Traditional And Modern Teaching And Learning*. In *Planning For Teaching Of Off-Campus Students*. Steyn, HJ. Potchefstroom: NWU.

Mouton,J. 1996. *Understanding Social Research*. Johannesburg: Van Schaik.

Mouton, J & Marais, HC. 1989. *Basiese Begrippe: Metodologie Van Die Geesteswetenskappe.* Pretoria: RGN.

Osguthorpe, RT & Graham, CR. 2003. Blended Learning Environments – Definitions And Directions. *The Quarterly Review of Distance Education*, 4(3): 227-233.

Ram, V. 1996. Intelligent Information Retrieval Support In Constructivist Learning Environments. *South African Journal of Higher Education,* 10(1):89-95.

Rossouw, J. 2004. Communication May 2004, Cape Town.

Steyn, HJ, Steyn, SC, De Waal, EAS & Wolhuter, CC. 2002. *The Education System: Structure And Issues.* Potchefstroom: Keurkopié.

Stoker, HG. 1961. *Beginsels En Metodes Van*

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Abstract

The simplicity of flashcards makes them ideally suited for memorizing word lists on small, mobile devices but flashcards are not well suited to subjects that require more sophisticated organizational structure. Legal outlines, for example, do not lend themselves well to the simple associative lists of flashcards. We describe how we adapted and enhanced user-interface design techniques so that they may be more effectively applied to the design of small, mobile devices in an unproven space rather than the more standard desktop applications for which a large body of user data exists.

Introduction

While mobile phones are ideally suited as replacements for cumbersome flashcards, a substantial body of content that students have to commit to memory do not lend themselves well to the simple format of flashcards. For example, a law student has to commit to memory, procedural options that define the steps in the prosecution of a lawsuit. Such advanced concepts are often organized as outlines where general steps are divided into specific substeps which themselves may be further divided in sub-substeps and so on. With a tremendous amount of content to master, law students are motivated to find study tools to help in the memorization process, including mobile tools. However, unlike flashcards—which suggest a very obvious user-interface given their simple front-back association—hierarchical outlines may invite numerous interface possibilities and it is not immediately obvious which would be best suited as a memorization—as opposed to a browsing—interface.

In our search for a solution, we found that, while numerous design guidelines for small, mobile applications have been proposed, the design process itself has had less exposure in the same domain. In this paper, we share some of the adaptations we made to a standard user-interface design process so that it would be more appropriate for designing mLearning applications. Two challenges that exist in the mLearning domain are the constraints imposed by the physical limitations and the dearth of usage data that could be leveraged as part of a standard design process. We also introduce a visualization technique we found useful in the development process and we illustrate an application of the design methodology in a case study that examines our solution.

Traditional and Mobile User-Interface Design Techniques

Numerous user-interface design methodologies exist, ranging from the classic top-down waterfall model to the highly iterative star life cycle to the reusable design pattern approach. Because most user-interface design methodologies are geared towards sophisticated desktop applications such as business programs, games or websites, we chose to use the Logical User Centered Interactive Design (LUCID) method, which focuses more on the user experience and is less dependent on the scale of the application. The phases of the LUCID approach are:

1. Envision the goals, requirements, constraints and functionalities
2. Analyze the user's mental model and habits
3. Design the prototype
4. Evaluate usability and design detailed interaction elements
5. Build and test

We made some slight adjustments to the phases because we found that, while this method is generally platform independent, limitations of small, mobile devices imposed such severe

constraints, that it is difficult to envision functionalities without better understanding the users. Because the field of mobile applications is relatively new, there is not a wealth of data on existing habits for use in design purposes. From a user-acceptance perspective, then, solutions for small, mobile devices are far more speculative in nature than their desktop counterparts. We therefore found it more effective to envision relevant constraints and functionalities after some user behavior data is acquired. While this may blur the distinct between product design and interface design, we believe that the perspective is not so much that product design occurs later in the process as much as interface design occurs earlier.

We also split the analyze phase into two distinct stages in order to clearly delineate the transition from user requirements to finding a solution in the constrained environment of small, mobile devices. We then address the constraints as a discrete problem and, based upon our solutions, we design the features and functionalities of the system. Our modified approach is as follows:

1. Identify goals
2. Collect usage data
3. Formalize pattern from data
4. Address constraints
5. Design features and functionalities
6. Build and test
7. Visualize user experience

In addition to the slight modification of the earlier phases, we added a visualization step as an aide in the iterative process. By visualization, we refer to the diagrammatic mapping of the user experience in order to see the experiential flow. We examine this in the next section.

Visualizing the Mobile User Experience

Designers need to have a global view of the applications they design but, in standard desktop applications, large feature sets often make this an unwieldy task when applied to user experiences. On the other hand, mobile phones are extremely constrained and, in such systems, it is not unrealistic to attain a global view over all the possible user experiences.

The mobile experience diagram—or mobex for short—arose from a desire to be able to visualize the various paths users can take and what consequences their choices will engender. Such a tool allows us to better control the user experience and hence avoid unforeseen states where the user is confused and frustrated.

We combined elements of flowcharts (for visualizing program flow) with elements of finite state automata (for visualizing simple state machines) to create a diagram tool that has states, transitions and control flow. Key elements of a mobile experience diagram, or *mobex*, include:

- State node – a circle with a label inside to indicate what the user sees;
- Transition arrows – an arrow connecting one state node to another, with at least one label, which is what the user does to trigger the transition (i.e., input) and optional commands to indicate what the system executes in response to the transition in addition to enter another state node;
- Programmatic arrows – a box indicating commands that are executed without user intervention and which may have multiple transition arrows connecting it to other state nodes; and
- Initiation arrow – an arrow with a filled arrowhead point to the state node that defines the start of the user experience.

Figure 1 shows a very simple mobex for a flashcard application. The start state is indicated by a filled arrowhead. Any programmatic settings are given as labels on the arrows. Here, after k is set to 1, we enter state F_k, referring to the fact that the front of flashcard k is shown to the user. When the user presses the *Next* key on the mobile phone's keypad, as indicated by the N on the transition arrow leading out of the F_k state node, a new B_k state is entered, indicating that the user is now shown the back of flashcard k. If the user presses the *Next* key again, the transition arrow from node state B_k is followed returning the user to state F_k, which now shows the front of the next flashcard since the index k has been incremented by 1, as indicated by the label associated with the transition arrow from B_k.

Figure 2 shows a slightly more complex diagram. We will return to how mobex diagrams can be used in practice when we examine how our application led to unexpected user experiences.

Study Tools on Small, Mobile Devices

We now turn to a case study which illustrates the user-interface design methodology described earlier as applied to a study tool for small, mobile devices.

When we launched the Mobile Prep mobile phone study application in a pilot study at a number of California campuses, including Stanford and U.C. Berkeley in March 2005, we believed that law students would comprise a large part of our user base. However, feedback indicated that, while law students do have a lot of material they needed to commit to memory and would like to use mobile phones as tools to that end, the nature of the material did not lend themselves well to our flashcard tool.

Legal procedures, which are typically presented in outline format, does not lend itself well to flashcards not only because of the volume of information but also because there is no inherent need for a “back” of the flashcard as no relationship exists to take advantage of that. However, a strong need for a memorization tool was expressed and so we searched for solutions to address the needs.

Creating the User-Interface for m-outline

For law students, financial analysts and generally students from any field that requires the memorization of structured outline material, we created a tool called m-outline. We examine the user-interface design phases for creating this solution.

Phase 1: Identify Goals

Our goal was to create a tool for small, constrained devices such as mobile phones, that would facilitate in the memorization of content presented in a structured, outline format. We would want the tool to be easy to use and offer the sort of features that would minimally account for the way students typically study paper outlines. Having established our goal, we were unable to envision much more without studying the needs of the users given the nascent state of the technology and the consequential lack of information on user preferences and habits.

Phase 2: Collect Usage Data

We created a focus group of 9 users and made informal observations of their study habits when they are memorizing paper-based outlines. Informal here refers to the fact that we would let them choose how and where they studied—e.g., libraries, cafes. This is in contrast to user studies that would include recording videos of user behavior and requesting that they verbalize their thoughts. Occasionally we would interrupt to ask questions but we generally left questions until the end to ask them to describe the manner in which they felt they were studying the material.

We focused on how they made use of the hierarchical structure of the outlines, whether there were critical aspects of the paper medium that may not lend itself well to a mobile device, and if they thought they had particular approaches of memorizing the material worth noting.

We observed that the material usually consisted of a considerable amount of text. No diagrams were encountered due largely to the nature of our focus group. Also, while outlines do not have associations as flashcards do, the hierarchical structure of the outlines encode relationship information that is critical.

Phase 3: Formalize Patterns From Data

Prior work exists on navigating through dense data by using collapsed structures but our observations for this type of content revealed particular study behavior possibly more appropriate for memorization than for browsing. We wanted to mimic such patterns, which included:

1. Linear read of the content, item by item – the student commits the content to memory by reading the outline much as a book

2. Direct jump to a particular item – the student jumps to a particular item, usually from recognition of the specific item of interest on the pages or through visual cues such as a highlighted section or the item designation (e.g., §1.3.4)
3. Skim and focus – the student skims the items in linear fashion without necessarily committing them to memory or even reading them entirely (either because they are not interested in those items or because they have already memorized them) before stopping at a particular item and focusing on it for memorization
4. Skip through headings – the student views all the items on the same level but skips all the subsections of those items

Knowing the patterns will evolved into features, we then address the constraints.

Phase 4: Address Relevant Constraints

Given the importance of the hierarchical nature of outlines, it is imperative that we preserve the structure, which is typically encoded by indentation. Since the screens on mobile phones are already very small, our challenge was to find a way to capture the hierarchical nature of the content while making optimal use of the screen real estate. We chose not to indent the text—so that we may fit as much as possible on the screen—but to indicate each item's relative level by coloring the background with “indentation bars” that would provide the necessary visual cues.

We also wanted to consolidate the navigation of the content into as few keystrokes as possible given the cumbersome nature of small devices. Our challenge here is to prioritize the features and map them onto button sequences that would allow immediate gratification as well as a gentle learning curve that would introduce users to more sophisticated features. Virtually all handsets come with two programmer-definable “soft” buttons. We chose to map the escape “Back” key to one and a notion of the “Next Item” onto the other. The directional pad, which offers 4 directional and 1 select key) was also employed but the user is given the ability to fully use the system with no prior training and on just the one soft button. The simplicity is meant to establish off immediate gratification and boost their confidence in using the application.

Phase 5: Design Features and Functionalities

We map out the functionalities in accordance with the patterns we formalized from Phase 3. In particular, we provide users with the ability to access items in the outlines in a linear fashion, in a direct fashion, and by the level of the sections.

The users have the following ways of navigating through the outline, utilizing:

1. Run – the user presses [Next] on the keypad to advance through the outline, item by item
2. Focus – the user can highlight any item by pressing [Left]; subsequently, the user can jump through the highlights sequentially by pressing [Fire]

3. Skim and Stop – the user can scroll ([Up] and [Down]) through the outline in *summary* mode and expand any item by pressing the [Next]
4. Overview – each item can be collapsed (to hide all its subsections) or expanded (to expose all its subsections) via [Right]; this option behaves like a typical graphical file system viewer
5. Ignore – each item can be "lowlighted" by pressing [Left]—which toggles through highlight, normal and lowlight states for an item—so that a Run traversal will skip them; unlike flashcards, they are not deleted because the context of where each item is placed relative to the other items is important to preserve in outlines

Further, we offer three views modes, which are toggled through with the [Right] key:

1. Full outline mode – all the items are fully expanded
2. Summary mode – all the items are represented in the display with only their first line
3. Tree mode – items below a particular level are hidden

Phase 6: Build and Test

We created the prototype and offered it to 6 of the 9 members of the focus group as well as 4 new members who did not participant in the usage data collection phase. We are still in the process of compiling the results but we have learned so far have been encouraging. User comments ranged from "great feature" to "I will definitely use it" to feature suggestions such as creating labels for each item for easy reference. However, there were problems: multiple users observed how confusing the Ignore feature was, resulting in an unpleasant user experience.

Visualizing the User Experience

Though the Ignore feature seemed like a useful idea, the user experience was potentially confusing. Specifically, the application was designed to ignore all subsections if a section were to be ignored. The reasoning was that, if a user knows a section well enough to ignore it, then all the subsections can also be ignored.

While the reasoning appeared sound, it turns out that users complained about being completely lost when they used that feature. It turned out that the visual change appeared so massive on a small screen, it made the implicit hiding of subsections disorienting. We observed a number of users trying to negotiate with that feature and it was evident that it was indeed a confusing feature.

Given the constrained visual environment, re-creating alternative options was tedious and of somewhat confusing. We created a mobex to visualize the various states the users can get into when dealing with the Ignore feature. We limited the mobex to the features connected to the

[Left] and [Right] keys (highlight and view mode, respectively) to simplify the diagram. We found that, no matter what approach we took, the mobex, as shown in Figure 3, displayed a complexity that was beyond our expectations for how the user may navigate the system.

Upon closer inspection, we noticed that one particular state had more incoming transition arrows than all the rest of the nodes. This wasn't apparent when the system was designed, given the numerous combinations implicit in the states. However, the mobex clearly indicated that there was a possibility that one particular state was causing a certain level of asymmetry. Since none of the states have any inherent priority over any other states, we decided to try to remove that extra transition.

The resulting mobex, as shown in Figure 4, was far more symmetrical, as would be expected in such a symmetrical system. While symmetry and cleanliness may not guarantee intuitive user experiences, they are indicative of a system that is, to an extent, predictable and orderly, which are factors that impact upon usability of applications.

The change, once visualized, required only minor re-coding of the Ignore feature. The resulting Ignore feature fared far better in user tests. Although it was arguable that the system was less efficient without the implicit collapse of subsections when a section was ignored, the users all tended to prefer the slower but predictable model over the faster but disorienting model. In this, the mobex diagram proved itself valuable as a tool to detect and remedy potential states of confusion for the user.

Figure 5 shows some screen shots of the completed application.

Conclusions

In our interest in creating study tools for students on small, mobile devices we found that traditional user-interface design techniques needed to be adapted to accommodate not just the physical constraints but the newness of the field, which provided little usage data we could leverage to assess functionalities early in the design process. By making slight variations on the standard methodologies we are able to better approach the design of mobile interfaces in a structured manner. We found that the ability to visualize mobile experiences graphically using mobile experience diagrams to be viable for small, constrained systems and valuable in detecting flaws in the design. Based upon the approach, we successfully created a study tool for small, mobile devices for use with structure outline content that advanced students may want to commit to memory.

References

Ballard, B. (2005). *User Interface Design Guidelines J2ME MIDP 2.0.* 2005, Little Springs Design.

Buyukkoten, O., Garcia-Molina, H., and Paepcke, A. (2001). *Accordion Summarization for End-Game Browsing on PDAs and Cellular Phones.* Proceedings of SIGCHI '01. 213 – 220.

Quesenbery, W. (2001). *Applying a UCD Process to Implementing a UCD Process.* Proceedings of the 48th Annual Conference, Society for Technical Communication, 2001.

Shneiderman, B., and Plaisant, C. (2005). *Designing the User Interface, 4th Ed.* Pearson Education, Inc.

Stone, D., Jarrett, C., Woodroffe, M., and Minocha, S. (2005). *User Interface Design and Evaluation.* Morgan Kaufmann Publishers.

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Table 1

Insert Table Title Here

Figure Captions

Figure 1. Simple mobex diagram

Figure 2. Slightly more complex mobex diagram

Figure 3. Very messy mobex indicating a troubled user experience

Figure 4. Clean mobex

Figure 5. Screen shots of the m-outline study tool

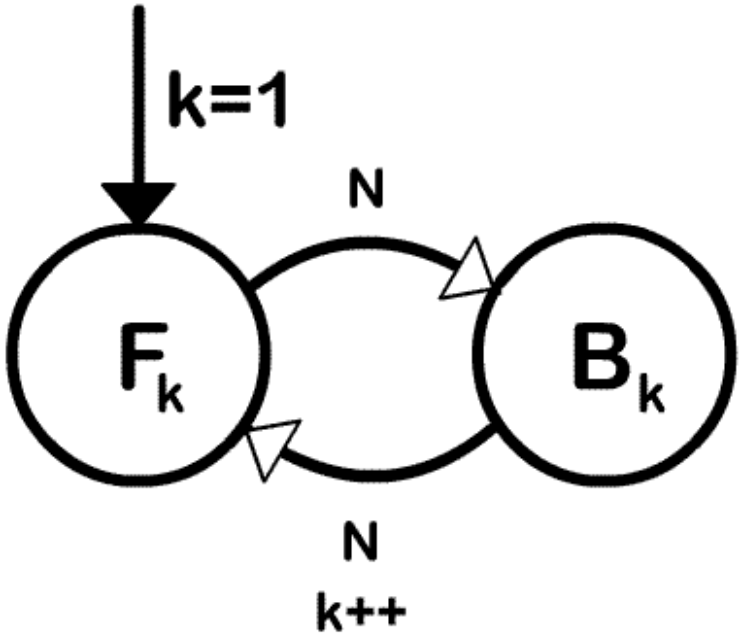

Figure 1

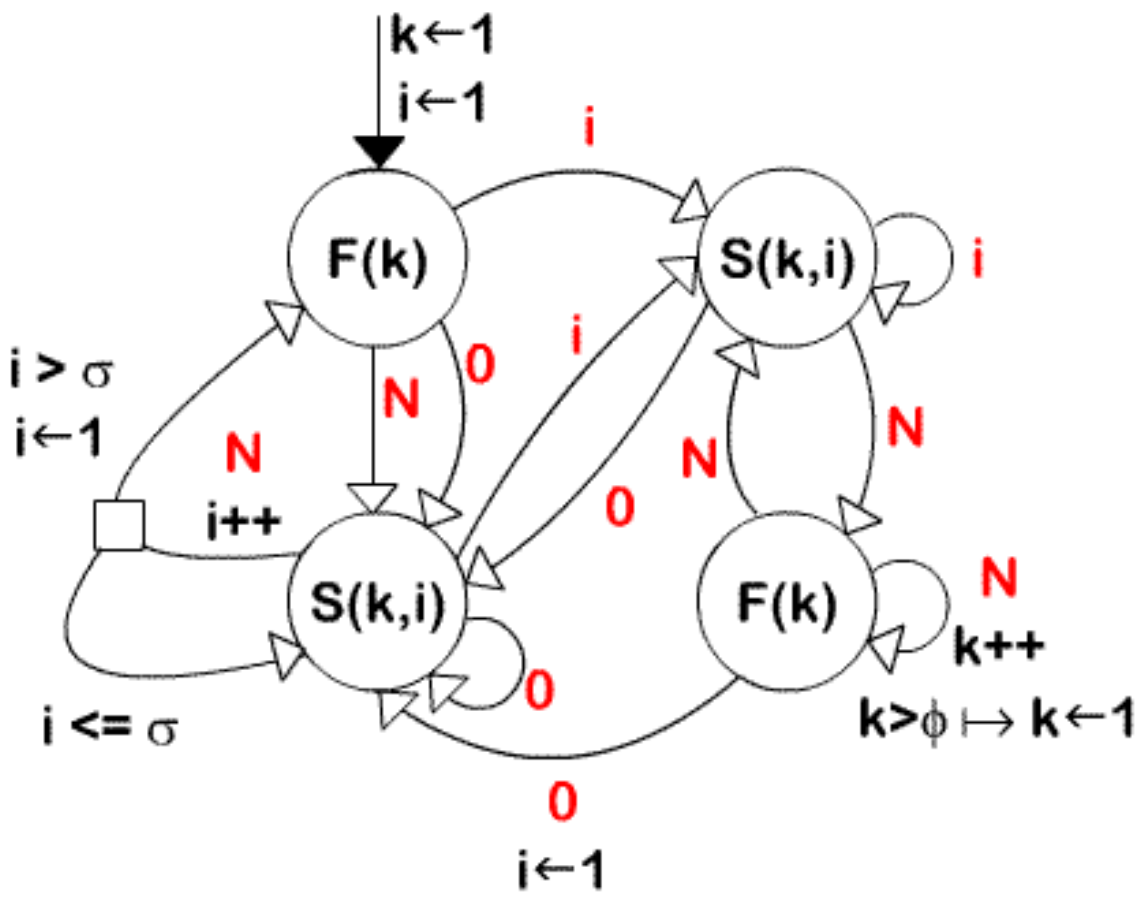

Figure 2

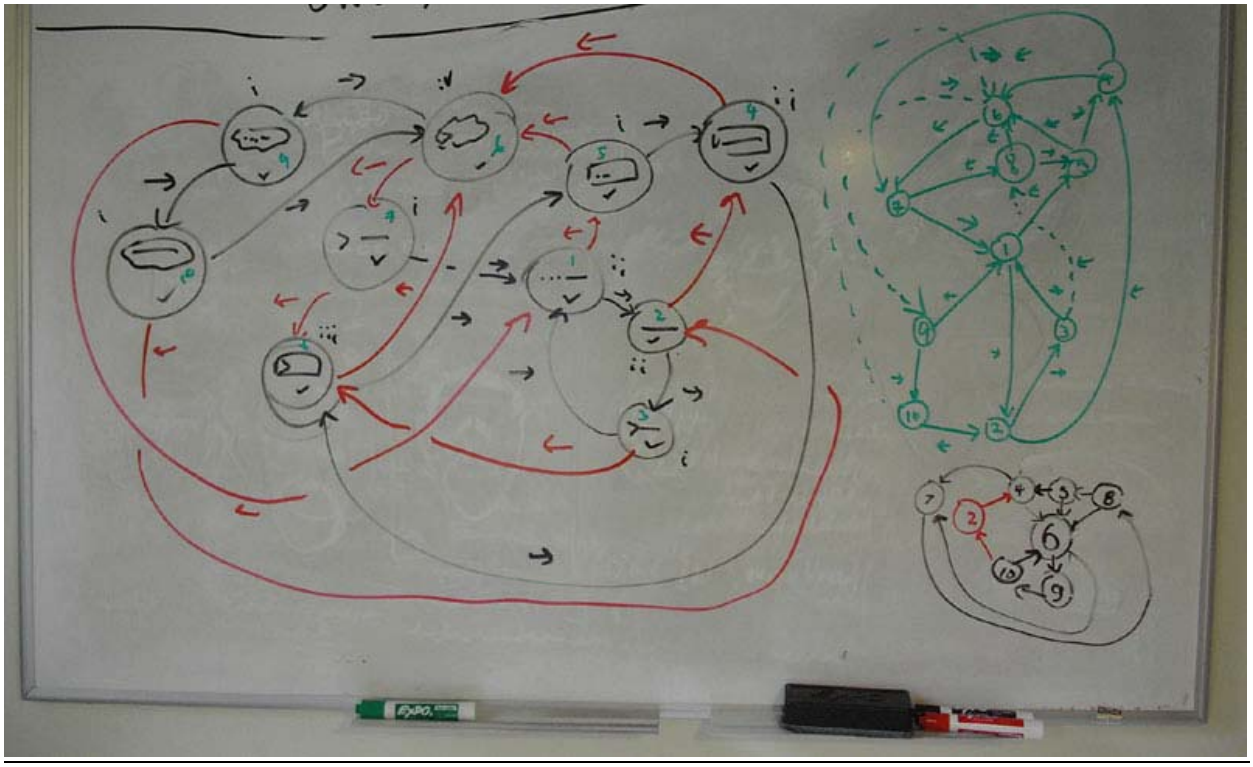

Figure 3

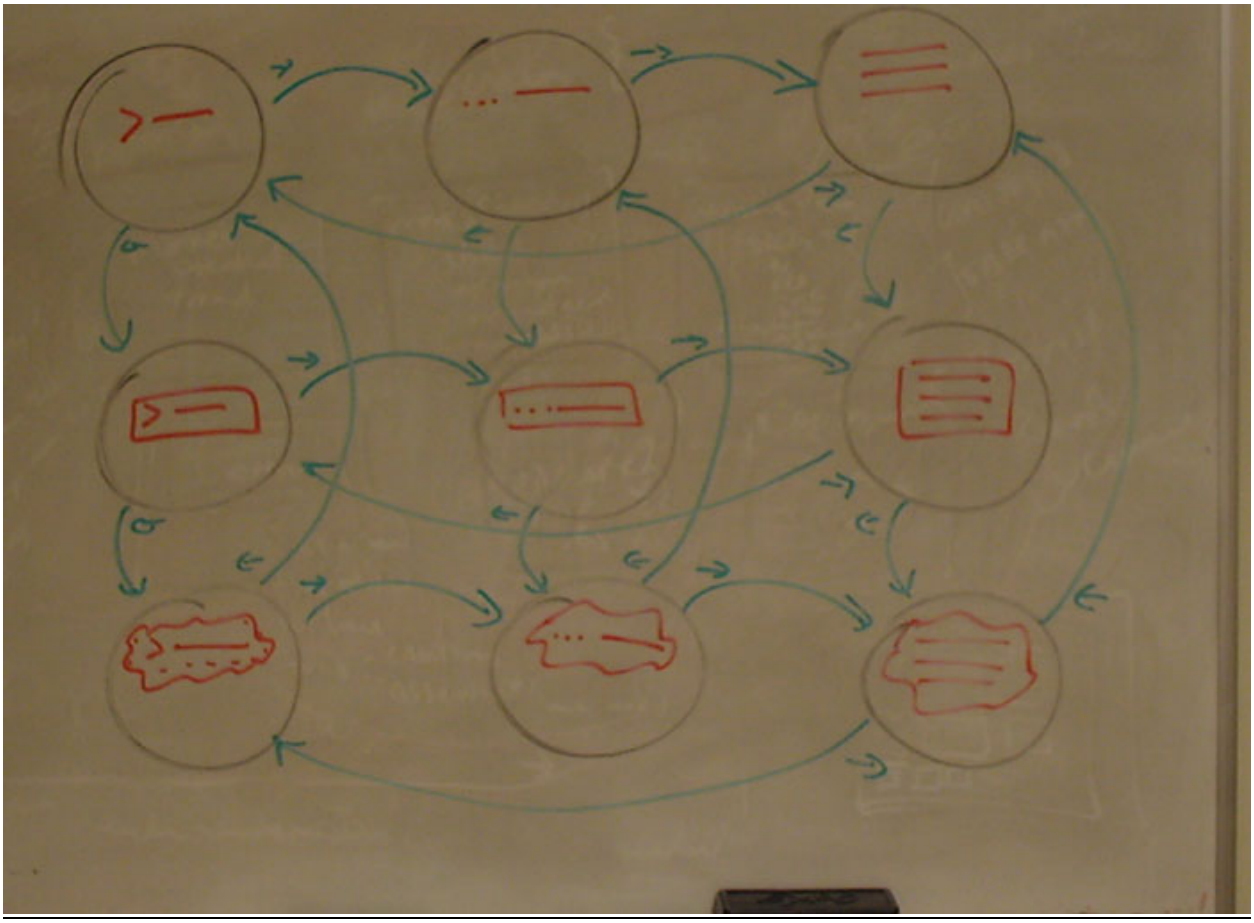

Figure 4

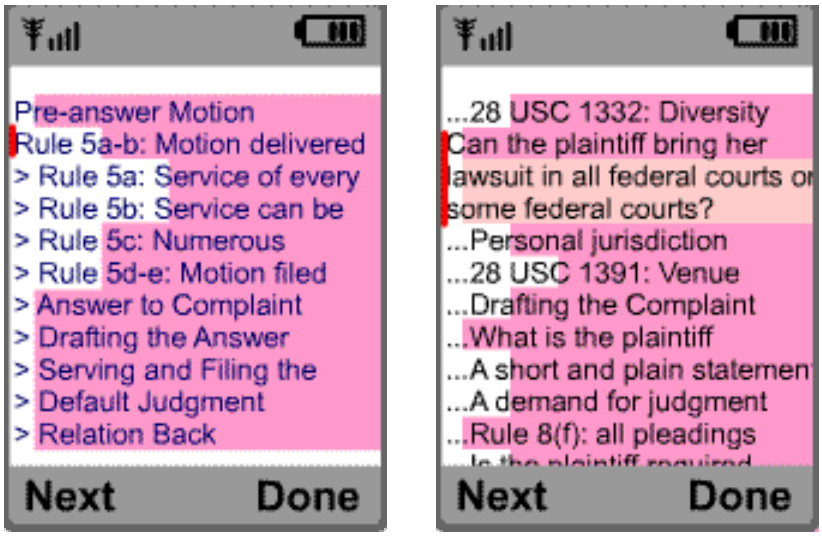
Pre-answer Motion
Rule 5a-b: Motion delivered
> Rule 5a: Service of every
> Rule 5b: Service can be
> Rule 5c: Numerous
> Rule 5d-e: Motion filed
> Answer to Complaint
> Drafting the Answer
> Serving and Filing the
> Default Judgment
> Relation Back
Next
Done
...28 USC 1332: Diversity
Can the plaintiff bring her
lawsuit in all federal courts or
some federal courts?
...Personal jurisdiction
...28 USC 1391: Venue
...Drafting the Complaint
...What is the plaintiff
...A short and plain statemen
...A demand for judgment
...Rule 8(f): all pleadings
Next
Done

Figure 5

Personal Digital Assistants – teachers prefer the personal

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Abstract

This paper will present the results of a small-scale project, funded by the UK Teacher Development Agency, where 13 teachers and 3 trainee teachers in one secondary school science department were given handhelds (Personal Digital Assistants or PDAs) with cameras and internet access for the academic year. The aims were:

- to build capacity - enabling trainee teachers to share their mlearning practice;
- to enable school based associate tutors to join the elearning community linked to the initial teacher training course and
- to encourage reflective practice amongst trainee teachers by enabling access anytime and anywhere to blogs for recording their teaching experiences.

However, initial indications are that not all these aims succeeded. The handhelds were viewed as personal devices rather than enabling access to a community of practice. Nearly all participants praised the personal information management functions of the devices but the teachers did not use the handhelds to access the course virtual learning environment and students did so only rarely. Email and SMS (texting) for both personal reasons and work within the school related context were more popular. Most popular were the multiple methods of recording available on the handheld: video, audio and written notes. Teachers used them to record observations on each others' lessons, students' work, student behaviour and trainees' progress in teaching. Whilst the concept of blogging did not appeal and was not used by the trainee teachers, they did record personal reflections on their teaching in Word. Finally, there were clear signs that the handhelds were taken out of the participants' pockets or bags to be used only when relevant and then replaced. This was perceived as a distinct advantage compared to desktop or even laptop based computers in the classroom with handhelds affording technology at a teacher's side and not in their face.

Introduction

In a comprehensive review of the use of mobile technologies such as handheld computers, personal digital assistants (PDAs) and Smartphones in learning and teaching Naismith et al (2004) identified aspects of learning relevant to students' use of mobile devices in both formal and informal learning contexts. In order to help them evaluate the most relevant applications of mobile technologies in education they classified these aspects into six groups that could be used to describe the use of mobile devices with students. Four of these classifications are linked to types of learning theory:

- behaviourist,
- constructivist,
- situated and
- collaborative.

Two relate more to context and application:

- informal and lifelong learning, and
- learning and teaching support.

It is this last area of learning and teaching support that is particularly relevant to initial teacher training where students move regularly between university and school placement and are expected to acquire, decipher and understand a wealth of information, both pedagogical and practical, in the process.

Another review, this time of innovative practice with e-learning in further and higher education within the UK (JISC, 2005) identified three key features of mobile technologies: portability, any time-any place connectivity and immediacy of communication that underpin their potential for learning and teaching support. These features: portability since PDAs are pocket sized; any time-any place connectivity as PDAs with GPRS or wi-fi connectivity enable flexible and timely access to e-learning resources; and immediacy of communication through 'phone or email, are leading to empowerment and more effective management of learners (especially in dispersed communities). Such a range of affordances for learning and teaching support bodes well for the potential use of PDAs with student teachers, who are expected to teach as well as learn during their training. Previous work with teachers using PDAs in schools (Perry, 2003) has shown that

PDAs can be supportive of teaching in that they offer considerable potential to make teachers' management and presentation of information more efficient. One Science teacher described their range of potential benefits to Perry; "I would never willingly go without one now; it is my instantly accessible encyclopaedia, thesaurus, periodic table, diary, register/mark book, world map and even star chart!".

Efficient management of information is indeed essential for students following the Postgraduate Certificate of Education (PGCE), a one-year science teacher training course in the UK. They need access to and a means to store information: on the National Curriculum, examination board syllabi and school based schemes of work; to supplement their subject knowledge; for course administration; for assignments and for pastoral support. Additionally, whilst the students are directly supported by a mentor from the school when on placement, their university tutor needs feedback on their students' progress and to assure themselves of their well being. Access to email and the internet has become essential to managing this process. However, whilst all community schools in England now have connected desktop computers, the socio-cultural context within the schools means that student teachers are reluctant to use these. They tend to be perceived as belonging to the pupils or other members of staff. Providing student teachers with PDAs is one way of resolving this issue and, indeed, previous research (Wishart, Ramsden and McFarlane, *in press*) where trainee teachers in Science trialled the use of internet enabled PDAs to support them in their teaching and learning has shown that this can be effective. Another study investigating the development of e-learning communities amongst initial teacher trainees dispersed on their school placements (Hughes, 2005) found that the students preferred PDAs to laptops as they were smaller and lighter. Wishart, Ramsden and McFarlane (2005) reported that their PGCE students could and did use their PDAs to access course related information. The students especially appreciated just-in-time internet access from any location for both personal and professional reasons and they stayed in email contact with their tutor though they preferred to use SMS texting or MSN to keep in touch with their peers. However, not all the student teachers used their PDAs regularly and many of the group were uncomfortable about being the only one in the class or school with a PDA.

Thus this project was set up with the main objective of building capacity within one school; enabling teachers and trainees in a science department to share their m-learning practice and allowing both students on placement miles away from the University and their school based teacher mentors to join the e-learning community linked to the PGCE course. Another objective was to encourage reflective practice amongst the trainee teachers. Employing reflective practice is recommended by Pollard (2005) as being of vital importance to teachers in order to develop evidence-informed professional judgement. The students would be able to use the PDAs anywhere and anytime to reflect on their teaching experiences by means of web based logs known as 'blogs'. These could enable both the recording of their reflections on teaching and allow the university tutor to have oversight of their progress as reflective practitioners. The blogs would also act as a mechanism for storing their reflections for later use in assignments.

Method

Thirteen science teachers at a local community school and six student teachers on the PGCE one-year teacher training course at the University of Bristol were given handheld computers to use throughout the academic year. These were PDAs chosen from the Pocket PC range then available in the UK that used the mobile phone GPRS network to connect to the internet and contained cameras. Previous research (Wishart, McFarlane and Ramsden, 2005) had shown that initial teacher trainees preferred Pocket PC based handheld computers to Palm OS based ones.

The models used in the study included Qtek 2020, Qtek 2020i, i-mate, XDA II and XDA IIi, almost identical hardware (shown in Figure 1) running Pocket PC 2003. The PDAs were supplied with aluminium protective cases and screen protectors. Separate collapsible Stowaway keyboards were provided where the participant requested one.

Figure 1. XDA II clone PDA

Mobile phone connectivity was supplied by Vodafone as it had

proved reliable in the project area in the earlier study. It was arranged that staff and students could receive and send up to a total of 6MB data including web pages, emails and texts a month without cost to them though they would be expected to pay for any voice calls they made.

The sample of teachers was selected through opportunity, with the head of chemistry at the school being an experienced PDA user and the head of science being willing to explore their use amongst his staff. The three students allocated to this school by the University during each of two teaching practices were then invited to join this study. All agreed though none of them had used a PDA before however, they had all used Word, Excel and Powerpoint in their studies and/or work.

On introduction to the mobile devices students and staff were shown how the PDAs have the potential to support them in:

- collaborating via the course Virtual Learning Environment (VLE) discussion groups and email;
- accessing course documentation (via the VLE or via synchronisation with a PC);
- just in time acquisition of knowledge from the web;
- acquisition of science information from e-books and encyclopaedias;
- delivering accurate figures for scientific constants and formulae;
- organising commitments, lesson plans and timetables;
- recording and analysing laboratory results;
- recording pupil attendance and grades;
- photographing experiments for display and reinforcing pupil knowledge;
- maintaining a reflective web log (blog) that could allow them to record lesson evaluations and other reflections on their teaching.

The six students were participant action researchers in the project acting on their teaching and learning by means of the PDA and then reflecting on and amending their practice (Wadsworth, 1998); they reported in by online questionnaire twice during the academic year. There was also

a dedicated discussion area on Blackboard, the course VLE, should they prefer this method of exchanging information and ideas about the PDA project. Additionally a focus group of all student PDA users was organised for the end of the first block of their teaching practice in order to collect impressions and share potential uses face to face.

Available teaching staff participated in a similar focus group discussion during the spring term and twelve were interviewed about their use of the PDA in the summer toward the end of the academic year. The totals given for number of teachers' responses in the results section vary as staff left during the discussions in response to pupil needs.

Results from teachers

Four to five months into the study, during the Spring term, teachers were asked to report whether they were still using the PDA. As shown in Table I. below only half were using their PDA.

Table I. "Are you still using the PDA?"	n
Yes	6
No	6

On discussing reasons for not using the PDA three clear positions emerged. These were choosing to use an alternative technology to support teaching, lack of engagement with the study and finding the PDA display difficult to read. Two teachers were not using the PDA as they now had alternative access to ICT which they found fitted their purposes better. Since the school had agreed to become involved with the PDA project each teaching laboratory had been equipped with a desktop computer, one teacher had purchased a digital camera and several had acquired USB memory sticks. All of these were suggested as being better for the purpose of designing presentations at home and bringing them to school for lessons. Another two teachers had not yet got around to trying the PDA out yet and a third teacher found having to manage glasses (as the display was too small) and the stylus simultaneously too much trouble.

Table II lists the activities that were reported by more than one teacher as being used successfully to support teaching and mentoring student teachers.

Table II. PDA Applications that Support Teaching	**Illustration**
Making notes in meetings or for lesson observations using Word	Figure 2.
Calendar /Diary Scheduler	Figure 3.
Taking photos and videos	Figure 4.
Searching /Research (internet)	

Figure 2 shows an example of the notes made by an experienced teacher during an observation of a student teacher's lesson, these were then beamed using infra-red to the student's PDA for her to include in her reflections on her teaching. The teachers noted the advantages of being able to use the PDA to quickly and easily make notes both in formal meetings and on accidentally meeting up with colleagues in the corridor between lessons.

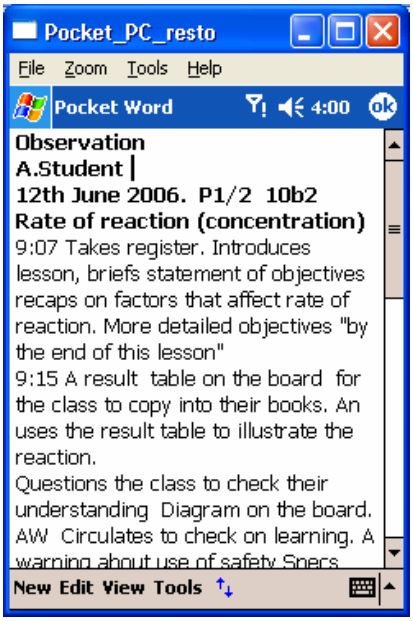

Figure 2. Lesson observation

Figure 3 is an illustration of how the Pocket PC Calendar can be used to display a teaching timetable, whilst the diary design was not as appropriate for teaching as customised timetabling software, it was still one of the most popular applications.

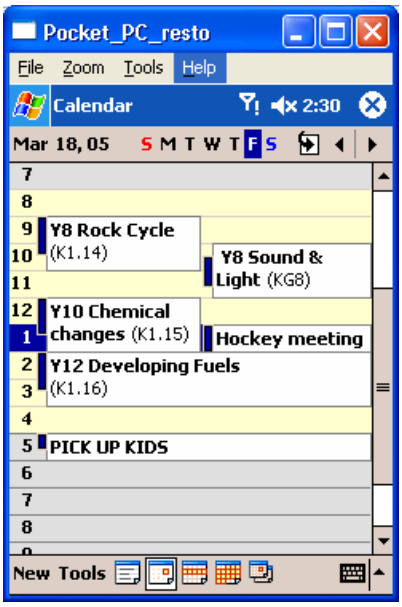

Figure 3. Calendar showing a teacher's diary

Two teachers, a biologist and a chemist, were particularly enthusiastic about the potential of using images to record day to day activity in lessons, as shown in Figure 4 and displaying them to the class as a reminder of previous work or revision at a later date.

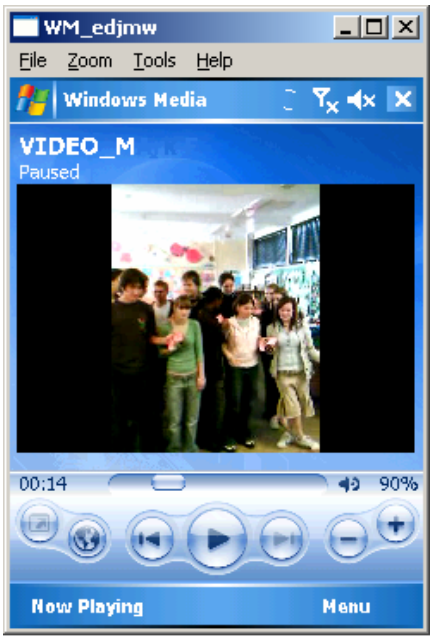

Figure 4. Using the camera

Access to the Internet was also reported particularly favourably especially for keeping abreast of breaking news usually unavailable during the school day (such as the cricket scores). Additionally one member of staff was very emphatic about how useful it was to set up a class administration system in Excel on a desktop computer and synchronise it to the PDA so that could be quickly and easily updated during lessons. He used multiple windows for attendance, grades, practical skills achieved and commendations etc. as shown in Figure 5 below.

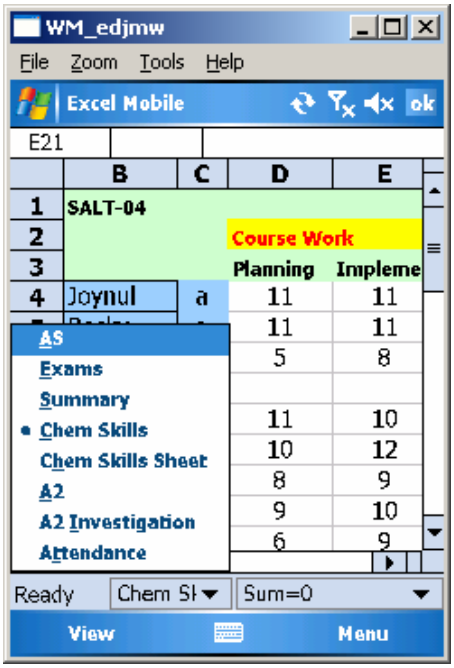

Figure 5. Using spreadsheets for class administration

However, when it came to participating in the e-learning community designed to support the student teachers in the school, as Table III shows, the teachers were less forthcoming.

Table III. "Communication with the PGCE students' tutor?"	n
I haven't	5
In person	1
By email from a desktop PC	1

In fact the teachers' communication using the PDA was much less than anticipated with only occasional use of SMS texts and email to contact each other or friends and family outside school. More use was made of beaming files to the student teachers than messaging or emailing them.

One teacher made innovative use of the PDA to support behaviour management in the classroom by recording a pupil's use of strong language during the lesson and playing it back to him afterwards. The student, who had previously been immensely tricky to deal with, immediately acknowledged that he'd been out of order and apologised.

Results from Student Teachers

Results from the online questionnaires completed by the six student teachers (three from the autumn term teaching practice who were allowed to keep their PDAs when they moved to a different school and three from the spring term practice) show similar trends. As Table IV shows, towards the end of the spring term just over half had given up using the PDA .

Table IV. Are you still using the PDA?	Autumn Term	Spring Term
Yes	3	2
No	0	4

Two students had given up as they had allowed the PDA battery to discharge and had lost their diaries and stored work, another found the PDA more hassle than pen and paper and another found it faster and easier to use a laptop that had become available. However, all the students agreed that using the PDA was easy and five of the six disagreed with the statement that the PDA was of no use to them as an individual. Though all the students trialled the applications used by the teachers as described earlier in this section there was no clear agreement amongst this group as to whether having a PDA might support their learning and/or teaching. There was clear agreement though that the two applications that were the most useful were the calendar for organising their timetable and the task list for organising their multiple commitments. They also used Word for making notes on lesson observations and for receiving feedback from experienced teachers on their own lessons.

The intended focus of the project for the students of sharing their reflections on their teaching experience with their tutors via a blog was not successful in that students in this study preferred not to use it but it was effective in proving that the software: Blogs in Hand on the PDA and Pebble on the server, worked effectively. One student sums it up neatly "I saw my school based associate tutor every day, so had little need to share thoughts and ideas with him in this way. Also, I prefer to keep my personal reflections to myself." The university tutor was simply not perceived of by the students as being in need of this information. Another student teacher pointed out "There seem to be more important things to do. Whether this is the case or not is debateable but that is the perception when you are on the front line, teaching." The students did however use the PDAs to reflect more privately using Word to make personal notes.

Finally, the several of the student teachers reported a feeling of confidence about their use of the PDA, being able to access the internet wherever they happened to be for both personal and professional information. Also the ability to use and then hide the PDA back in a pocket or bag led to it being perceived as educational technology that was more manageable in front of pupils than a desktop computer. The objective of the study to build capacity in m-learning within one school was met in that no-one reported feeling uncomfortable about using a PDA in the classroom though sharing innovative practice was more successful amongst the chemists amongst whom there was a keen PDA user.

Discussion

This small-scale study clearly illustrates the overwhelming nature of the social and cultural context in which new technologies are trialled. Of the three aspects cited by JISC (2005) as being key to the use for mobile and handheld technologies for learning and teaching support, portability and any time-any place connectivity were clearly important to both the teachers and student teachers but immediacy of communication was not deemed relevant to their needs. The university tutor's perception that she needed to be party to the students' development whilst on placement was not shared by the student teachers who reported that they felt their training needs were met by the school. In particular the concept of blogging as a way of encouraging and

sharing reflections on teaching was not supported by the six students in this study. This result needs further research to ascertain whether it is student and/or school specific. For instance, another e-learning communities in initial teacher training project carried out in London (Jack and Scott, 2005) investigating university tutors communicating with their students by means of video-conferencing found that such conferencing worked well with particularly needy students.

The handheld PDAs were used successfully by some of the teachers for personal support with timetabling, records of meetings, observations, students' attendance and grades, images and just-in-time information from the internet thus fulfilling the enabling person-plus vision for information and communications technology (ICT) originally put forward by Perkins (1993). However, several months into the study half the participants were not using the PDA, some of these had moved on to other technology that had become available and, in the case of the teachers involved, some had not started yet. Thus the teaching staff appear to be following the bell curve model of diffusion of a successful innovation proposed by Rogers (1995) and shown in Figure 6.

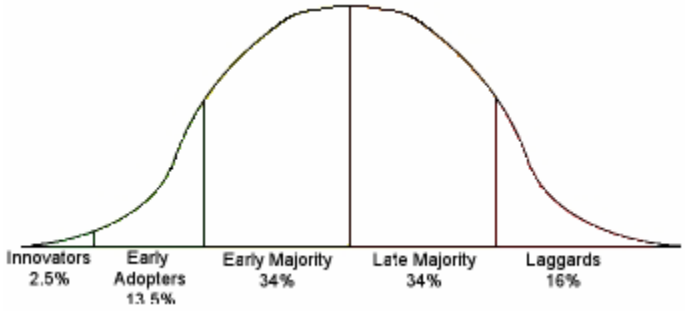

Figure 6. The five categories of potential innovation adopters (Rogers,1995)

At the tail end there were the two teachers who had yet to try the technology and the four who were not convinced of its use. However, in this study, the leading edge of early adopters had not settled on the PDA as it competed with other recently acquired technological innovations. Digital cameras and USB sticks which were considered better by two of the teachers for designing presentations for lessons at home and bringing them to school for lessons. Those teachers and student teachers that continued to use the PDA prioritised its organisational and personal management functionality which, of course, is the original design brief for a *personal* digital assistant. Though these teachers used PDAs to support their pupils' learning by, for example,

using the camera to record layout for a class practical and audio recording to support class management they did not use the PDA for presentations.

Both teachers and student teachers recognised the potential of the PDA for learning and teaching support as described by Naismith at al (2005) and identified the same three software applications as central to this potential as in the earlier study by Wishart., McFarlane and Ramsden (2005). These were the calendar or diary scheduler for organising yourself, the spreadsheet of attendance or mark book for organising your pupils and the use of a word processor to make notes on information and events immediately they are encountered.

There were clear signs that seeding a science department with PDAs led to greater confidence amongst the student teachers about their use than in the earlier study (Wishart, Ramsden and McFarlane, *in press*). The handhelds were taken out of the participants' pockets or bags to be used only when relevant and then replaced. This was perceived as a distinct advantage by the inexperienced teachers compared to desktop or even laptop based computers in the classroom with the handhelds affording technology at a teacher's side and not in their face.

Conclusions:

Despite acknowledging their potential for supporting collaboration teachers mostly view PDAs as personal devices. Not all participants were sufficiently interested to trial the devices and the perceived lack of reliability where this generation of PDAs can lose their data if the battery is allowed to discharge was a significant barrier to their engagement.

However, providing a PDA for all teachers within a department enabled a culture for student teachers where their use could be experimented with and the experienced teachers that continued to use the PDAs found that they provided individual teaching support through:

- internet access;
- taking photos;
- class administration and

- in particular, diary scheduling.

Additionally, recording notes on students' lessons and using the infra-red beam to share them was very useful to both the teachers and trainees who continued to use the PDAs. However, the objective for this study of using blogging to facilitate reflective practice was not met. The student teachers were not comfortable with the concept of sharing their lesson observations and their own reflections on their teaching beyond the school where they were placed.

Finally, for effective deployment of mobile devices in teaching and learning support there needs to be recognition of PDAs and other Smartphones as part of the 'whole' ICT system within an institution. Issues such as using the wi-fi to connect to the wireless network, connecting the PDAs to the data projectors and connecting the PDA cradles to the classroom desktops need a significant amount of facilitation in the school context where access to computer networks is heavily restricted.

References:

Hughes, S.A. (2005) JANUS project – looking back to the future. Available online at http://www.tda.gov.uk/upload/resources/doc/e/e-learning-case-studies.doc#_Toc92694920 [Accessed 9th November 2006].

Jack, D and Scott, R. (2005) Partnership with Schools through WebCT and Videoconferencing. Paper presented at TDA E-learning and Teacher Training Conference 11th November 2005

Naismith, L., Lonsdale, P., Vavoula, G. and Sharples, M. (2004) *Report 11: Literature Review of Mobile Technologies in Learning.* Bristol: Futurelab.

Perkins, D. N. (1993). Person-plus: A distributed view of thinking and learning. In G. Salomon (Ed.) *Distributed cognitions* (New York, Cambridge University Press), 88-110.

Perry, D. (2003) *Handheld Computers PDAs in Schools.* Coventry: British Educational Communications and Technology Agency. Available online at http://www.becta.org.uk/page_documents/research/handhelds.pdf [Accessed 6th March 2006]

Pollard, A. (2005) *Reflective Teaching: Evidence-Informed Professional Practice.* London: Continuum

Rogers, E.M. (1995). *Diffusion of innovations (4th ed.).* New York: The Free Press.

Wadsworth, Y. (1998) What is Participatory Action Research? Action Research International, Paper 2. Available online at http://www.scu.edu.au/schools/gcm/ar/ari/p-ywadsworth98.html [accessed 24th July 2006]

Wishart, J., McFarlane, A. and Ramsden, A. (2005) Using Personal Digital Assistants (PDAs) with Internet Access to Support Initial Teacher Training in the UK. Paper presented at MLearn '05, Cape Town. Available online at http://www.mlearn.org.za/CD/papers/Wishart.pdf [Accessed 9th November 2006].

Wishart, J., Ramsden, A. and McFarlane, A. (in press) PDAs and Handhelds: ICT at your side and not in your face. *Technology, Pedagogy and Education.*

Running head: PARTICIPATORY SIMULATION LEARNING ALGORITHMS

Using Participatory Simulation Support Learning Algorithms

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Abstract

During learning computer science theory, it is essential to learn sorting algorithms, but it is not easy to understand the concept of the different sorting algorithms. This paper describes a system called PLASPS (PDA-based Learning Algorithm System Using Participatory Simulation). This is an interactive simulation system to learn the sorting algorithms. Learners use it to deeply understand the sorting algorithms. Using this system, the teacher can assign tasks to his student and ask them to sort a list of numbers according to a certain algorithm. Learners receive these tasks, collaborate together and send the result to the server. The system will check it and feedback the student with the positions of the numbers if there is a mistake. The learners will correct the number positions and send it back to the server. Learners can understand the algorithm through the dissections and their errors.

This system is like 'scaffolding'. Scaffolding is a great technique that can help the students to master understanding the sorting algorithm. At the beginning, this system assists the students by supporting some instructions, and later the fading process is starting where the students have to practice independently. There are two parts in this system, one is the system-driven, which uses scaffolding technique, and the other is the learner-driven, which allows the student to work independently.

This system was developed and evaluated. In this paper, we describe how the system uses participatory simulation environment for sorting algorithm learning, how we use the scaffolding technique to develop this system. We also describe the implementation of the PLASPS, the evaluation of the system and the plan of the future work.

Using Participatory Simulation Support Learning Algorithms

1. INTRODUCTION

Recently, with the evolution of improved wireless telecommunications capabilities, open networks, continued increases in computing power, battery technology, and the emergence of flexible software architectures, these technologies can be commonly used in mobile learning. Mobile devices (e.g., PDA's or notebooks) provide different services aiming at the improvement of interactivity and creating additional, computer-moderated channels of communication between the learners and the teacher (Papert, S. and Harel, I. 1991). The poor communication between students and teacher is one of the major problems in mass lectures. However, mobile devices can reduce this problem and by improving the interactive communication help to increase the motivation of the students (Papert, S. and Harel, I. 1991). Further, mobile handhelds can easily be used in any classroom or field site; hence they can be used more often than computer labs (Vahey & Crawford, 2002). Using mobile devices for supported collaborative learning is known as MCSCL (Mobile-Computer Supported Collaborative Learning). Nowadays, there are more and more supported learning researches about MCSCL in order to enhance learning and teaching (Okada et al. 2003;Chen et al., 2002). Many studies have examined the use of wireless mobile devices in learning. According to (Roschelle, J. 2003), "90% of teachers in a study of 100 palm-equipped classrooms reported that handheld was an effective instructional tools with the potential to impact learner learning positively across curricular topics and instructional activities." The MCSCL is classified as follow (Roschelle, J. 2003):

(1) **Classroom response systems**: This is a system where learners can answer the teacher's question immediately with a mobile device, and the system will then display the total result. According to this result, the teacher can grasp the understanding condition of each learner

about the course content. The system turns every learner into an active learner. For instance, "ClassTalk" [http://www.bedu.com] is a classroom response system that shows teachers the statistics of learners' answers in the classroom immediately.

(2) **Collaborative data gathering**: The mobile learning environment changes the monotonous way of teaching in the classroom whereby the learners are only listeners. It lets the learners gain experience from real life, and deeply understand what they have learned. The learner touches and feels the actual object. For example, the Bird Watching Assistance System (Chen et al., 2002) was developed for this purpose to support the learning environment.

(3) **Participatory simulations**: This is to let the learner understanding the course content better through the participation/practice. The learner uses a mobile device to take part in a common participatory simulation. Through this active participation, the learner can discuss and get the correct answer, consequently understand what they have learned better. For example, the Virus Game was developed by the MIT (Vanessa et al., 2002) to explain the process of how virus is spread.

(4) **Others applications:** As like other researches, the system is being developed in the university, which uses PDA to support the study activity. For example, in Tokushima University, we have a project called BSUL (Basic Support for Ubiquitous Learning) (Saito, et al., 2005) to aid study activity.

In this paper, we use the scaffolding technique to design a participatory simulation framework to support collaborative learning, called SPS (Scaffolding Participatory Simulation). Based on the SPS framework, we have implemented a system support to learning sorting algorithm called PLASPS (PDA-based Learning Algorithm System Using Participatory Simulation). This system was then implemented and evaluated.

There are 3 important keywords in most CSCL papers and researches, authenticity, scaffolding and reflection. SPS framework uses the participatory simulations method to realize authenticity, and it was designed using the scaffolding technique, and in the framework, history records are then used to realize reflection. In the following sections, we describe how scaffolding technique is used to design the SPS framework and the characteristics of the SPS framework, and how the SPS framework uses participatory simulation for learning. Finally, we will describe the implementation and evaluation of PLASPS and the plan for the future works.

2. PARTICIPATORY SIMULATION

During the past ten years, computers have been used increasingly as simulation machines. The widespread popularity of game software like SimCity and SimEarth give a clear indication of the extent to which simulation has permeated popular culture, participatory simulations grew out of an age-old tradition of using role-playing to help people develop personally meaningful understandings of complex or nuances situations (Vanessa et al., 2002). Students engaged in participatory simulations act out the roles of individual system elements and then see how the behaviour of the system as a whole can emerge from these individual behaviours (Wilensky, 1999). Participatory simulations are learning games where players play an active role in the simulation of a system or process. Simulations of this type have recently come to the attention of educators through the work of Colella (Colella, 2000). Students participate in an active way, analyze information, make decisions and see the outcome of their actions. This increases the motivation and the learning success improves.

The SPS framework focuses on the participatory simulation that is to learn the concept (or rule) through doing it. Using SPS-based system, the teacher can assign tasks to his learner and ask them to do the task, and learners receive these tasks, collaborate together to do the task.

The system supports the learner to do the task step by step, the system will check every step and feedback the learner, learners can understand the concept (or rule) through their trial and errors, when the learner masters the concept (or rule) on a certain level, the system will reduce the help function gradually and more responsibility is shifted to the learner. As mentioned above, the SPS framework is used to build the PLASPS system. In this system, all the learners stand in a line with PDA, and the teacher can assign tasks to his learner and ask them to do the task by using the system, and learners receive these tasks, collaborate together and exchange their physical positions according to the algorithm. This system helps the learner to deeply understand the feature of the sorting algorithms.

This research is advocated by pedagogical theories such as hands-on learning and authentic learning. Brown, Collins, and Duguid (Brown et al., 1989) define authentic learning as coherent, meaningful, and purposeful activities. When classroom activities are related to the real world, learners receive great academic rewards. There are four types of learning to ensure authentic learning: action learning, situated learning, incidental learning, and experimental learning (Ogata and Yano, 2003, Ogata and Yano, 2004). SPS framework employs two forms of authentic learning; action learning and experimental learning based on face-to-face communication. SPS framework brings the learners to learn in the 'real world'. The SPS framework also employs interactive learning. Interactive learning involves interactions, either with other learners, teachers, the environment, or the learning material.

3. SPS FRAMEWORK

The SPS framework comes from the traditional education and can be seen as an extension of the traditional education. In the traditional education system, teachers give priority to the learners, and learners are normally very passive. For example, in learning computer science

theory, when the teacher teaches some complicated concept or algorithms, they only explain literally but it is difficult to make it clear to the learners. So making use of this framework, a mobile system to help students to understand the concept easier and clearer is developed. Besides, it improves the interactive communication, and increases the motivation and enthusiasm of the learners.

3.1 What is scaffolding?

Before moving on to the framework, we would like to explain the term 'scaffolding'. The term 'scaffolding' comes from the works of Wood, Bruner and Ross (Wood et al., 1976). It can be explained better with the following sample. For example, earning to ride a bicycle gives children a wonderful sense of accomplishment. Many of us can recall running alongside a child, holding the bike steadily as the youngster gained speed and then wobbled off independently, unaware that he or she was pedalling without support (Feldman, 2003). Scaffolding, as provided by human tutors, has been well established as an effective means of supporting learning (Soloway et al., 2001).

The timing of the scaffolding is very important. When the children are just learning to ride bicycle, it is necessary to hold the bike steady for giving s/he wonderful sense, when s/he can pedal without support, if we still hold the bicycle, it will hinder s/he to achieve more speed. Now we should begin the process of "fading", or the gradual removal of the scaffolding, which allows the learner to work independently.

3.2 Design of SPS framework with scaffolding technique

The design of SPS framework is divided into four sequential parts (see figure 1), the first one is the initial process, the second one is the system-driven part, which is the process of scaffolding to support task execution, and the third is the learner-driven part, which is the

process of "fading" to train the learners to think by themselves and the last part is the reflection part.

During the initial process of learning and problem solving, the teacher will provide general ideas, concepts, rules, examples and etc to the learners to guide them and to make sure the learner have a basic idea of what has to be learned. Following that, the system-driven component will assist the learners by providing some instructions, the learner will gain experience from the aid and help messages provided by the system to tackle the problems presented in the PDA. After some practices using the PDA to solve problems, the learner will gradually learn and understand the methods and techniques to solve the problem, when the learners become more experienced with the concept (or rule), the fading process is started where the learners use the learner-driven to practice independently. On the other hand, the system will reduce help messages gradually and more responsibility is shifted to the learner. Lastly, the learners will be able to solve the problem themselves without the help of the system. At the end learners can reflect with the history record.

Insert Figure 1 about here

3.2.1 Initial process. The teacher explains the concept (or rule), and point out the major emphasis, and then explain to learners how to use the system, at the end explanation will be conducted using the examples in help page. This is very useful to help learners to understand.

3.2.2. System-driven. In the system-driven part, the system guides the learner to do the task step by step. The system-driven acts like a bridge used to enable learner to master the concept (or rule). All the learners do the task using PDAs. The system will give guide them on how to do the task. The learner could discuss and compare with his other learners by indication, before exchanging the position. Here, mistakes are expected from the learners, but the system

will provide the learners with some information, which points out the position if it is incorrect and how to correct them for the learners to be able to achieve the task. The learner comprehends through participation in the discussion and help from the system to understand the feature of this concept (or rule). There are three characteristics to support learners in system-driven:

1. Discussion and help with each other.
2. Pointing out the error position.
3. Providing messages to correct the error.

3.2.3. ***Learner-driven***. The learners use the learner-driven system to practice doing the task by themselves. When the learner masters the concept (or rule) on a certain level, the process of fading begins. The teacher will judge according to the level of understanding of the learners and reduce the system's help function gradually.

We design the learner-driven into three levels depending on the process of fading as in Figure1:

Level 1 only points out the error, but the method on how to correct it must be completed by the learners, and they can discuss and compare with his neighbouring learner, before exchanging the data.

Level 2 does not point out the error, and the learners have to correct it by themselves. They can discuss and compare with their neighbouring learner before exchanging the data.

Level 3 (see Figure 2) lets everyone do the task with the PDA. For example, there are 5 learners with PDAs named A, 1, 2, 3 and 4. Learner 1, learner 2, learner 3 and learner 4 each one represents a number and Learner A will have to rearrange the numbers according to the task. Learner A stands before them indicating how to do switch positions and do the task. Facing the

other learners, leaner A orders them to exchange their position without discussion. If Learner A passes the third level, we can say s/he can complete doing the task independently.

Insert Figure 2 about here

3.2.4. Reflection. Every step is stored in the history record, after finishing the task, the learners can see the history of the each step, which points out the wrong positions for the learners and its corrections. With the history record learner can reflect the algorithm.

3.3 Characteristics of the SPS framework relating to Educational Scaffolding

Here are the characteristics of the SPS framework relating to educational scaffolding as below (Jamie, 1999):

3.3.1. Provision of clear directions. SPS framework offers step-by-step directions to explain just what learners must do in order to meet the expectations for the learning activity. A message about how to do the task will be provided to support every step.

3.3.2. Clarification of purpose. SPS framework keeps purpose and motivation in the forefront. Scaffolding aspires to meaning and worth. At first teacher should explain the concept of algorithm, and point out the major emphasis includes what target will be achieved. The SPS framework will help learner to do the task based on the target every step.

3.3.3. Keeping learners on task. By providing a pathway or route for the learner, each time a learner or team of learners is asked to move along a path, the steps are outlined extensively. SPS framework checks every step, and the right step will be shown to the learners.

3.3.4. Assessment to clarify expectations. From the very start, SPS framework provides examples. By these examples they can know what result will be at the end. Right from the beginning, learners are shown rubrics and standards that define excellence. In traditional school

research, learners were often kept in the dark until the product was completed. Without clearly stated criteria, it was difficult to know what constituted quality work.

3.3.5. Reduction of uncertainty, surprise and disappointment. SPS framework designers are expected to test each and every step in the lesson to see what might possibly go wrong. The idea is to eliminate distracting frustrations to the extent this is possible. The goal is to maximize learning and efficiency. Once the lesson is ready for trial with learners, the lesson is refined at least one more time based on the new insights gained by watching learners actually try the activities.

3.3.6. Efficiency. If done well, a SPS framework should be efficient. This perception is achieved, in part, by virtue of comparison with the old kind of school research that was mostly about wandering and scooping. Boredom fed by irrelevance slowed the passage of time. It took forever to get the job done. SPS framework still require hard work, but the work is well centered on the inquiry, focused, clear and the learners are well channeled, avoiding unnecessary effort.

3.3.7. SPS framework creates momentum. In contrast to traditional research experiences, throughout which much of the energy was dispersed and dissipated during the wandering phases, the channeling achieved through scaffolding concentrates and directs energy in ways that actually build into momentum. It is almost like an avalanche of thoughts, accumulating insight and understanding.

We use the SPS framework to develop the PLASPS system, which was modeled following the standard specifications of Java 2 Platform, Standard Edition (J2SE), and using Apache Struts, which used the MVC (Model-View-Controller) architecture scheme. We chose this architecture because the re-usability components and the previous experience in developing web applications under this specification (Ayala and Saito, 2003). Apache Struts is based on the

structure of MVC (Model-View-Control). Struts-config.xml is an important partial disposition file of Control, which defines alternations between the pages, and works like the event mechanic for the user's interface.

An exciting aspect of wireless mobile technologies for education, as described in the literature today, is that tools that first existed only on expensive desktop machines are now being made available on inexpensive handheld units (Soloway et al., 2001). We used wireless LAN (IEEE 802.11b), Tomcat 5.0 as the server, run it on desktop computer, and learners run this system on Pocket PC2003, and Access database. We have finished the development of the System. The system is described as the following:

Insert Figure 3 about here

4.1 Architecture

There are 6 sorting algorithms in this PDA participatory simulations' system. They are Bubble Sort, Insertion Sort, Selection Sort, Quick Sort, Heap Sort, and Shell Sort. We set the number of learners between 3 and 9 in the same time. There are three modules in the system driven part (see Figure 3).

4.1.1. Server module. The server will send messages to the teacher or the learners. Each time after sorting, the server will receive data records from the learner module and the server will save these data records automatically. With these records, the server will validate the sorting whether it is correct or not, and send messages to the learners or teacher.

4.1.2. Teacher module. The main job of the teacher module is to select the sorting algorithm and set the number of the learners. After the random data is generated, the teacher

sends this data to learners. The teacher can use a desktop personal computer or a PDA for this purpose.

4.1.3. Student module. The learners will get the data to be arranged from the server according to the ID of the learners. Then the learners have to analyse, compare, discuss, and swap the obtained data. The result will then be sent to the server and the server will make a comparison of the correctness of the result. At the same time, the teacher can view the result and also measure the understanding of the learner and revise any new ways to explain the compilation of data.

4.2 User Interface

We have designed the system as a central server, with four interfaces, the first one is a user interface for login, the second one is a learner interface, the third one is a teacher interface, and last one is a help interface.

There are two types of users, the teacher and the learner. The system can detect the user type from his account and display the correct interface accordingly.

4.2.1. Help interface. Before using the system, the learners should know the concept of the sorting-algorithms, and how to sort these algorithms.

Insert Figure 4 about here

4.2.2. Teacher Interface. As shown in figure 4, there are three check options in this interface, for error checking, a help message to correct the error and a choice for either ascending or descending sort. When the error checking option and help message option is on, it is in the system-driven mode, if one or all of them are off, this system is in the learner-driven mode.

The teacher logins as a teacher user, the teacher window will appear as shown in (A) In 'Selecting for teacher' window, the teacher can select the sorting algorithms and set the number of the learners. If the selection is ok, the numbers and first-time position will appear as in the (B) In the 'Saving for teacher' window, the system will generate a list of random of numbers and send this list and the position number to the learners. P1, P2, P3…PN are the positions of the number and this data will be saved in the database, these are all the setting for the teacher. Then, when the teacher clicks 'next' the sorting will be started. The system will assign one number in this list to each learner. The system also will assign one number in this list to each PDA.

4.2.3. Student Interface. As shown in figure 4, when learners login with the user ID, the (C) 'Initialization for learner' window will be shown. When it is refreshed, the number of the users will appear as in the (D) 'Step for learner' window. There are also messages from the server and the position of each number. The learner will change his location and the number position according to the sorting algorithm. The 'upload' button is used to send the result to the server after every step. Students can also review the sorting algorithm here and also the number of loops for the algorithm.

4.4 Scenario

This is a scenario about using the system. The teacher assigns an array of numbers to his learners and asks them to sort these numbers according to a certain algorithm. Learners receive these tasks, collaborate together to do the task and the result of each step is sent to the server. The system will check it and feedback the learner with the positions of the numbers if there is a mistake. The learners will correct the number positions and send new position again to the server. Learners can understand the algorithm through discussions and their errors.

Figure 5 is a sample using the system-driven of learning bubble sort algorithm with ALGOS. In the evaluation conducted in a sorting algorithm class, there were altogether 30 students and a teacher. The students were divided into 3 groups and were instructed to use this system at the same time. In the case, the teacher chose the bubble-sorting algorithm. The system generates the data randomly and sends them to the learners. In the example shown, the array list "84,94,43,93,96,83,14,93,99,58" will be sorted descending. Learners will stand in a line with a PDA, which displays their numbers and positions.

Insert Figure 5 about here

At the beginning the system will give hints and instruction to solve the problem. In loop 1, a help message like this will appear initially: "The first person (in this case P1) has to compare and change his position with the neighbour if it is not in descending order". After the comparison, the new position is uploaded to the server. The students will also change their physical standing position in the line. The server will evaluate the change of positions and send an error message if the change was done incorrectly.

In case of mistake in the change of positions, the message will then ask the learners to correct it such as: "Numbers 84 and 94 are not in descending order, please change your positions". Conversely, if the positions were changed correctly, the server will generate a message like this: "P2 and P3, please compare your order and upload the new positions". As in the case of P1 and P2, if the change was incorrect, the server will generate a message to aid the learners again and vice versa if the change was correct. This process is also carried out for the other learners until P10.

As we move on to Loop 2, each learner will discuss and compare with his neighbour learners according to the messages from server as in Loop 1 and this process goes on for a few loops depending on the problem until the whole array is sorted. In each loop, circled numbers are correct and fixed while the underlined numbers indicate that these positions require changes in next loops.

5. EVALUATION AND EXPERIMENTAL RESULTS

5.1 Single group

In order to evaluate the usability and get some feedback for this system, we asked 10 learners to evaluate the system twice. 10 PDAs were used in this system too. They are all master students who learned the sorting algorithm about 3 years ago when they were undergraduate students. Each student holds a PDA with a number and stands in a line to sort (see figure 6). Most of them have not used the sorting algorithm for a long time so they have forgotten the rule of the sorting algorithm. We are proposing that they can use the system to review the algorithm again.

Insert Figure 6 about here

We chose learners who have not used sorting algorithm for a long time to get their feedback and the efficiency of re-learning the sorting algorithm again using the system.

Most of the learners commented that they could learn how to sort algorithm using this system, and it is a good way to explain the algorithm by the participatory simulation. This system gives the opportunity to the learners to see in practical how the sorting algorithms are done.

After completing these two experiments, we get the comment from these learners for improving the interface such as “please change the position of the buttons”, after we improve the

system, we evaluated system again. In these two experiments, we obtained some comments as in table1. According to the comments, we concluded that it is a good method to study by this system, which is similar to playing games in class. It is more interesting than just learning by teaching material.

Insert Table 1 about here

5.2 Multiple groups

Multiple groups can use this system at the same time. For the third experiment, we asked 30 learners to evaluate the system and divided them into 3 groups. Figure 7 shows a scene of different groups learning. And we divided the learner into 3 groups and named them A, B, and C.

Insert Figure 7 about here

After completing the experiment, a system evaluation questionnaire was given out. The learners evaluated the system by grading each of 10 questions, which is given from point one being the lowest to five being the highest (1: totally disagree, 2: partially disagree, 3: Neither agree nor disagree, 4: partially agree, 5: totally agree). The average of the points was 4.0. Table 2 shows the results of the evaluations by the questionnaires.

According to Question (1), the system is helpful for learning algorithm. Question (2), the system checks each step and gives helpful information, the result was not as good because they said there are some message not point out the error position. Question (3), the evaluation was not as good because this was the first evaluation and the interface of system were not user-friendly enough. After that, we did some modifications on the interface the result of the evaluation improved. Modifications will be made gradually from time to time to improve the user-

friendliness of the system. We also need more explanation for the learners how to use it. Question (4) shows they like using this kind of system to help learning.

From the results of question (5), they can understand the algorithm better after making mistakes. Question (6,7) using this method, they can help each other well. Question (8, 9) shows that they can understand the algorithm deeply and was enlightened by the discussion. Thus, we are also thinking about how to enlighten and help to improve the understanding of learners learning sorting algorithms. In the discussion, they can tell each other what they have comprehended. And they like the way of studying by discussion. Question (10) uses this history record to reflect the process of the sorting; they can reflect the process again. Some learner commented that by the history record they can know the whole process, and they can ponder and reflect the algorithm from the history records.

Insert Table 2 about here

Most of the learners commented that they could learn how to sort algorithm using this system, and it is a good way to explain the algorithm by the participatory simulation. This system gives the opportunity to the learners to see in practical how the sorting algorithms are done. But the system is not easy to use.

From the evaluation, we can observe that the students were able to learn better and enjoy the learning process in such group settings. Each group would compete with each other to be the fastest to sort the algorithm.

6 CONCLUSION AND FUTURE WORKS

This paper describes the SPS framework, which was designed using scaffolding technique The SPS framework uses the participatory simulations method to realize authenticity,

and in the framework, history records are then used to realize reflection. Based on this SPS framework, the PLASPS system was implemented and then evaluated. The teacher can use this system to help the learner to understand the algorithm deeply. We found that it was very easy for learners to understand and the main goal is achieved, whereby each learner understood the algorithm deeply.

The PLASPS system can help learners learn sorting algorithm. The scaffolding technique is suitable to support teachers in interactive lectures. A major advantage of participatory simulations is the fact that it is easier for learners to see patterns and understand coherences. With all the technical advances it is of particular relevance to keep in mind that only a part of the learning can be done with participatory simulations. The communication and discussion is always an essential part of the learning process. We believe that the emerging field of mobile interactive services and participatory simulations improve learning especially in the case of complex problems.

This system is still not that user-friendly. Thus, we are planning to improve the interface and ease of usability, which will be a new topic to be explored in the future. We will have more evaluation of this system in the class to get more in-depth feedback from the learners in order to test and improve it to achieve the goal of using it in class.

References

Ayala, G. & Saito, N. (2003) 'Using the JSP model 2 architecture for implementing agents for lifelong learning environment', Proceedings of the EDMEDIA 2003, (1), Honolulu, HA, June 2003, pp. 436-433.

Brown, J. S., Collins, A. and Duguid, P. (1989) 'Situated Cognition and the Culture of Learning', Educational Researcher, (Jan.-Feb.), pp. 32-42.

Chen, Y.S., Kao, T.C., Sheu, J.P. and Chiang, C.Y. (2002) 'A Mobile Scaffolding-Aid-Based Bird -Watching Learning System', Proceedings of IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE'02), IEEE Computer Society Press, Växjö, Sweden, pp. 15-22.

Colella, V. (2000) 'Participatory simulations: building collaborative understanding through impressive dynamic modeling'. Journal of the Learning Sciences, 9(4), pp. 471-500.

Colella, V., Borovoy, R., and Resnick, M. (1998) 'Participatory Simulations: Using Computational Objects to Learn about Dynamic Systems', Proceedings of the Computer Human Interface (CHI) '98 conference.

Feldman, S. (2003) 'Building Scaffolds in You Classroom', Teaching Pre K-8, pp. 6.

Jamie M. (1999) 'From Now On The Educational Technology Journal', http://www.fno.org/dec99/scaffold.html.

Ogata, H. and Yano, Y. (2003) 'How ubiquitous computing can support language learning', *Proc. of KEST 2003*, pp.1–6.

Ogata, H., and Yano, Y. (2004) 'Context-Aware Support for Computer-Supported Ubiquitous Learning', Proc. of WMTE 2004, IEEE Computer Society Press, pp.27-34.

Okada, M., Yamada, A., Tarumi, H., Yoshida, M. and Morita, K. (2003) 'Digital-EE II: RV-augumented interface design for networked collaborative environmental learning', Proc. of CSCL 2003, pp. 265-274.

Papert, S. & Harel, I. (1991): 'Constructionism, chapter Situating Constructionism', Ablex Publishing Corporation, Norwood, NJ.

Roschelle, J. (2003): 'Keynote paper: Unlocking the learning value of wireless mobile devices', Journal of Computer Assisted Learning, Vol 19, pp. 260-272.

Saito, N., Ogata, H., Paredes, R., and Yano, Y and Ayala, G. (2005) 'Supporting Classroom Activities with the BSUL Environment', Proc. of WMTE 2005, IEEE Computer Society Press, pp. 243-250.

S. Kopf, N. Scheele, L. Winschel, and W. Effelsberg (2005): 'Improving Activity and Motivation of Students with Innovative Teaching and Learning Technologies', Methods and Technologies for Learning, pp. 551-556.

Soloway, E., Norris, C., Blumenfeld, P., Fishman, B.J., K. & Marx, R. (2001) 'Devices are Ready-at-Hand', Communications of the ACM, pp. 15–20.

Vahey, P., & Crawford, V. (2002) 'Palm Education Pioneers Program: Final Evaluation Report', Menlo Park, CA: SRI International.

Wilensky, U. (1999), 'Learning Through Participatory Simulations: Network-based Design for Systems Learning in Classrooms', Computer Support for Collaborative Learning, pp. 667-676.

Wood, D., Bruner, J.S., and Ross, G. (1976) 'The role of tutoring in problem solving', Journal of Child Psychology and Psychiatry, Vol 17 , pp. 89-100.

Author Note

Insert Author Note Here.

Table 1

Insert Table Title Here

Table1: Advice of interface.

	What do you think about this learning method?
1	It is very easy to be understood using this way of teaching algorithm.
2	We can exchange our views on the solution of the algorithm and get the best way to solve the problem.
3	In this way I can get help from the other learner
4	Studying in this way is quite easy to understand, just like studying in games.
5	Learning from using the system is more interesting than learning from teaching material in a normal class setting.
6	We can do revision on the algorithm learned in class with this system.

Table 2 Results of questionnaire.

	Questionnaire	**AVG**
1	Do you think this system is helpful for learning algorithm?	4.0
2	The system checks each step and gives helpful information; do you think it is helpful?	3.5
3	Do you think this system is easy to use?	3.2
4	Do you want to keep using this kind of system to help learning?	3.9
5	Can understand the algorithm better after making mistakes?	3.9
6	Can you understand deeply when you get help from the other learners?	3.7
7	Can you explain well when you help some else?	4.1
8	Do you understand deeply and enlightened by the discussion?	3.5
9	Do you think it is interesting to study while discussing with other learners?	4.2
10	How about using this history record to reflect the process of the sorting?	4.0

Figure Captions

Figure1. Design of SPS framework

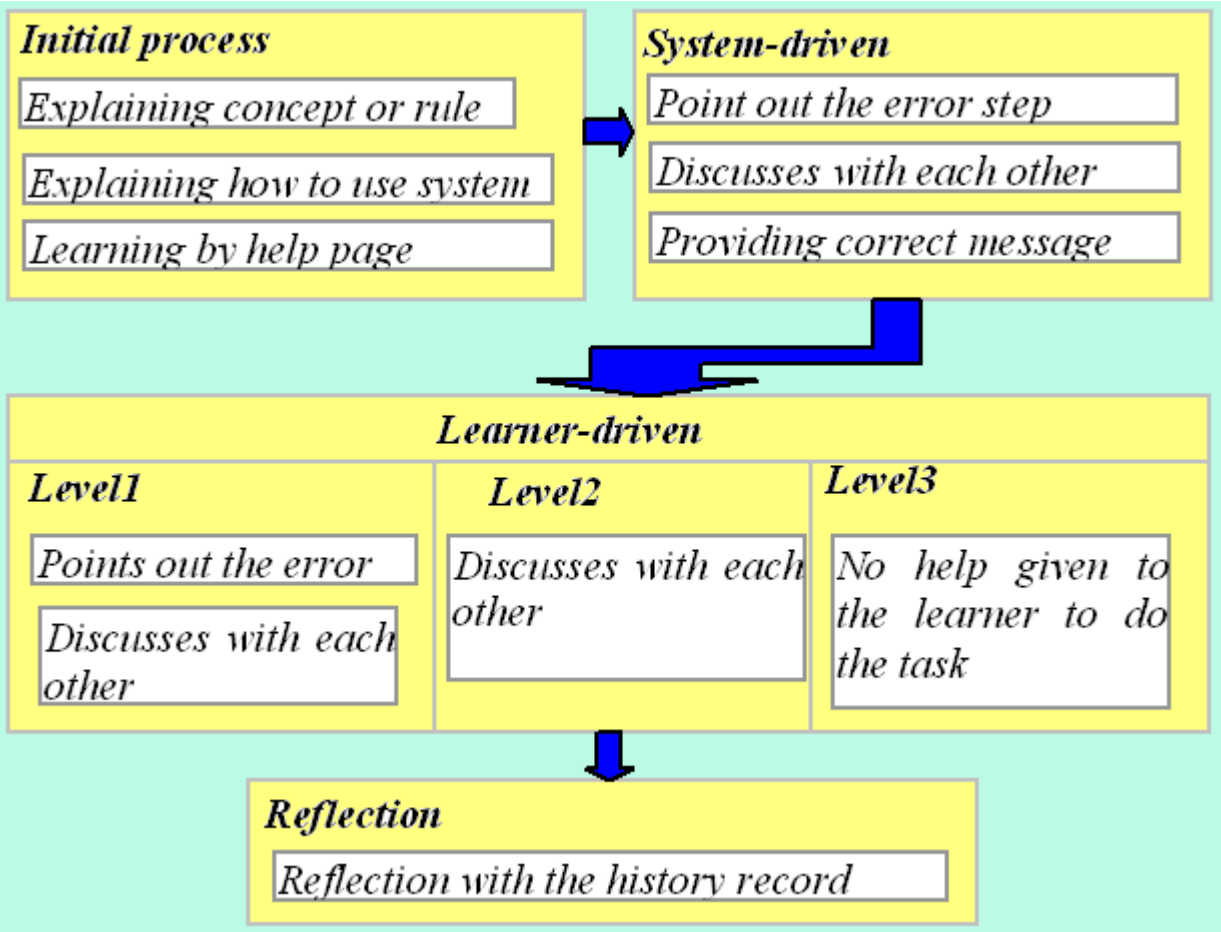


Figure2. Overview of Level3

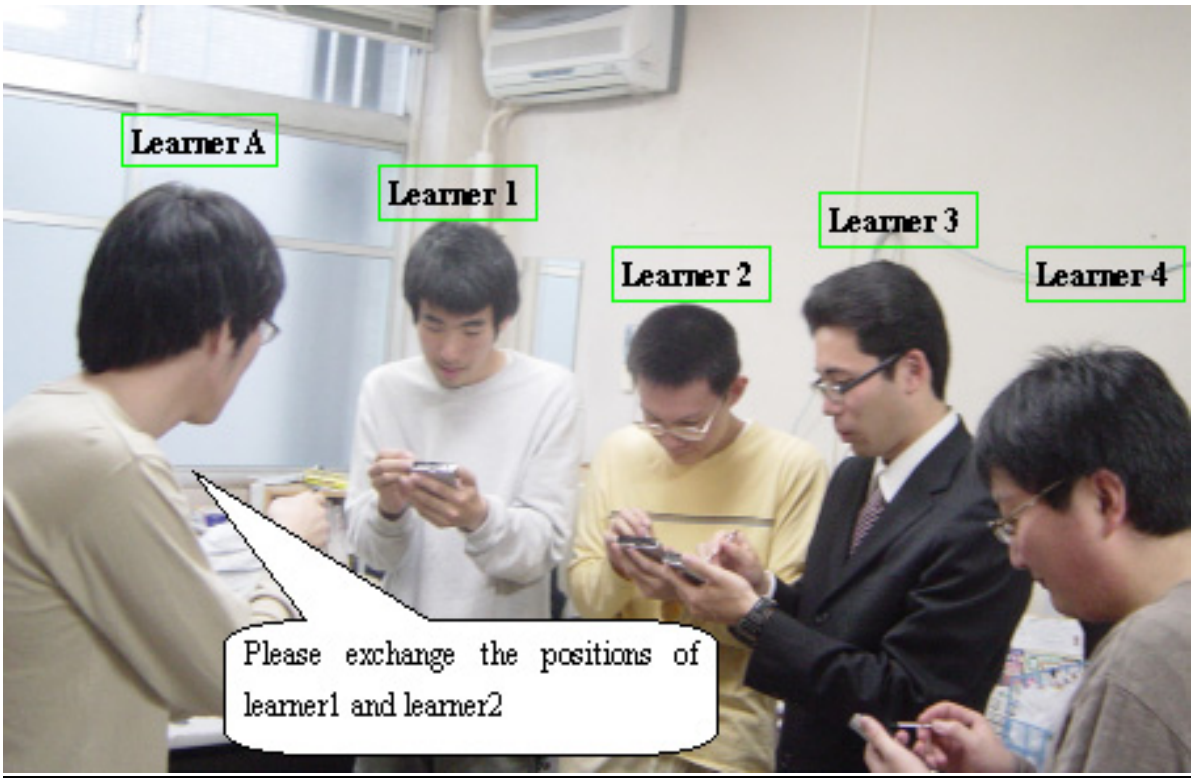


Figure 3 Architecture of system

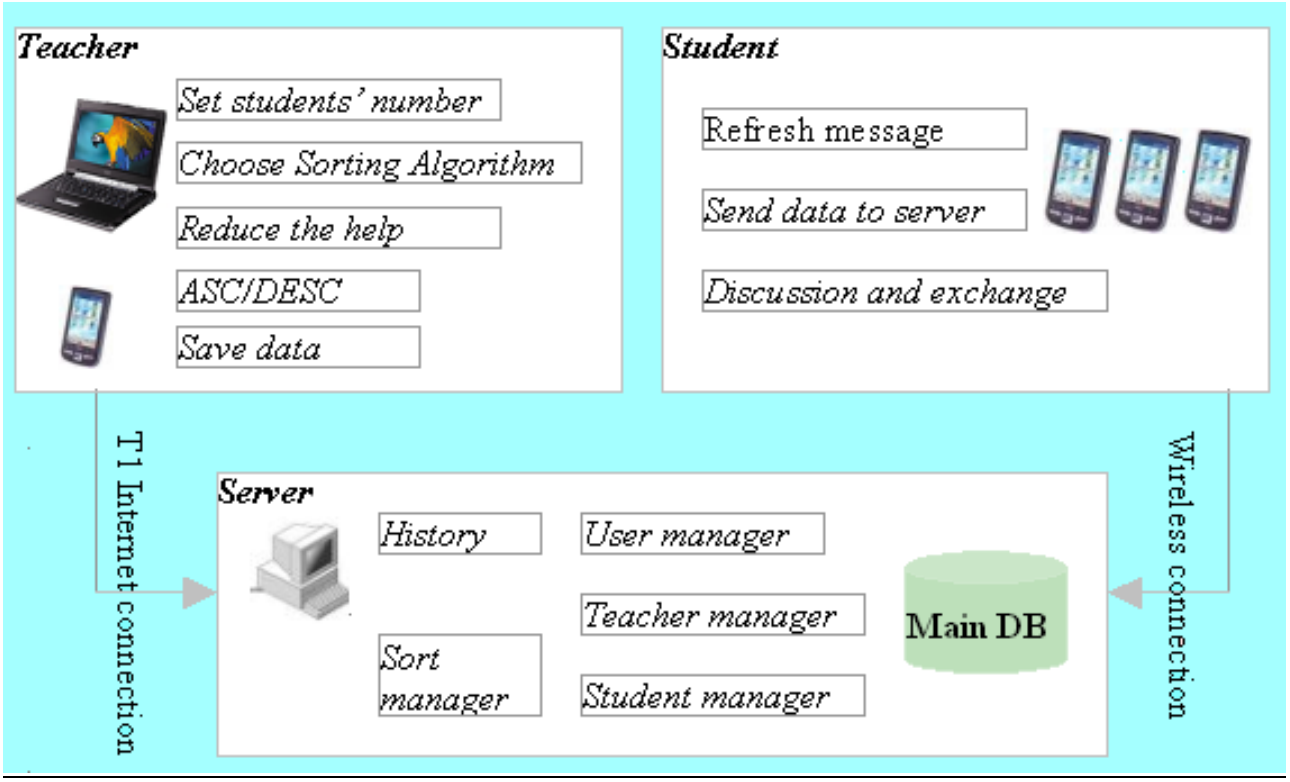
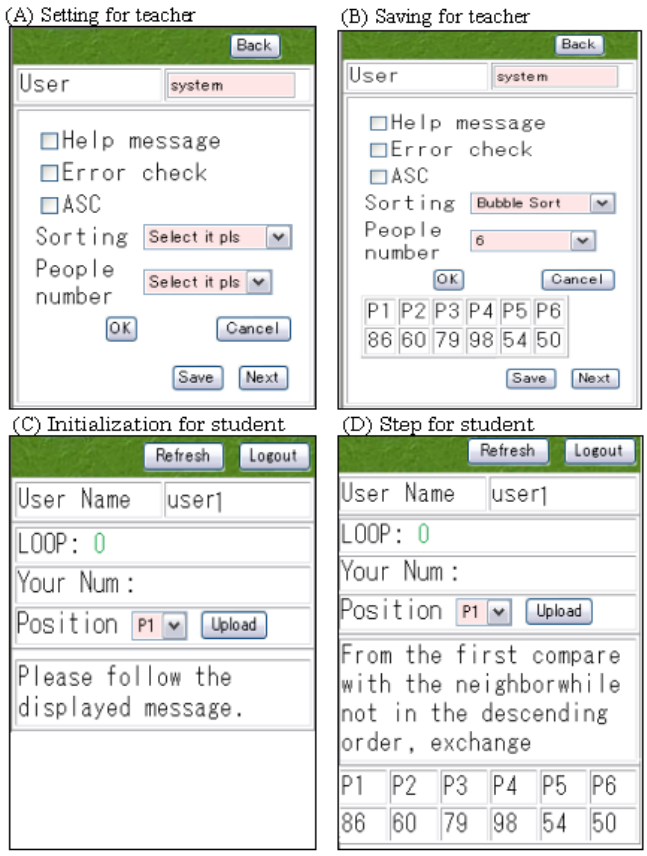


Figure 4 Interface of system



	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Start	84	94	43	93	96	83	14	93	99	58
Loop1	94	84	93	96	83	43	93	99	58	14
Loop2	94	93	96	84	83	93	99	58	43	14
Loop3	94	96	93	84	93	99	83	58	43	14
Loop4	96	94	93	93	99	84	83	58	43	14
Loop5	96	94	93	99	93	84	83	58	43	14
Loop6	96	94	99	93	93	84	83	58	43	14
Loop7	96	99	94	93	93	84	83	58	43	14
End	99	96	94	93	93	84	83	58	43	14

Figure 5 Bubble sort

Figure 6. View

Figure 7. A scene of different groups learning