Mobile learning anytime everywhere

A book of papers from MLEARN 2004

Edited by Jill Attewell and Carol Savill-Smith

MLEARN 2004

m-learning

mobilearn

Università Cattolica del Sacro Cuore

learning and skills development agency

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Foreword

We are delighted that our two mobile learning research and development projects supported by the Information Society and Media Directorate-General – m-learning and MOBIlearn – were able to collaborate to organise the very successful third annual MLEARN conference, MLEARN 2004.

The vision of the Directorate-General's Information Society Technologies (IST) priority is 'anywhere anytime natural access to IST services for all' and mobile learning is starting to contribute to the realisation of this vision. Projects such as m-learning and MOBIlearn are improving our knowledge of mobile learning and helping us to investigate how this type of technology-enhanced learning can facilitate learning process in different learning situations for diverse groups of learners.

The MLEARN international conference series has become the primary forum for mobile learning developers, researchers and enthusiasts to meet and exchange experiences, results, findings, tools and ideas thus contributing to knowledge and growth in this new field.

The venue for MLEARN 2004 – the beautiful and historic Odescalchi Castle in peaceful Bracciano outside Rome – provided a dramatic setting for the very lively proceedings including demonstrations of the latest technologies, systems and learning materials as well as exciting new ideas about teaching and learning.

This book contains the papers presented at the conference which we hope you will find interesting, informative and inspiring.

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Introduction

The authors who have contributed to this book are researchers, developers and practitioners in both educational and commercial organisations from a number of different countries. They have in common an interest in the still new and quickly evolving field of mobile learning.

The papers (including full papers, short papers and posters) are based on presentations given at the very successful and enjoyable international conference, MLEARN 2004, which had as its theme 'learning anytime everywhere'. The conference was hosted at the Odescalchi Castle in Bracciano, Rome and was organised by the MOBIlearn project, in collaboration with its sister project, m-learning.

Some of the papers detail the findings of mobile learning projects; some are based on desk research and attempts by the author(s) to identify and further develop theory relevant in mobile learning; and many report on work in progress. Work in progress includes both research and the development of mobile learning materials and systems.

The conference also hosted the First International Workshop on Mobile Learning for Emergency Management (MLEM), and the papers relating to this workshop are grouped together in a dedicated section of this publication.

Many of the papers have been written by colleagues who are partners in one of the two large mobile learning projects supported by the European Commission's (EC) Information Society Technologies' (IST) programme – m-learning and MOBIlearn. Further information about the projects can be found on their websites at www.m-learning.org and www.mobilearn.org

MLEARN 2004 built on the success of MLEARN 2003, which was also organised by the m-learning and MOBIlearn projects. A book based on the papers presented at MLEARN 2003 – on the theme of 'learning with mobile devices: research and development' – is available from the Learning and Skills Development Agency (LSDA) and can be downloaded in pdf format from the LSDA website (www.LSDA.org.uk).

MLEARN is now well established as an annual international event and MLEARN 2005 will be held in October 2005 in Cape Town, South Africa. MLEARN2005 is being hosted by the Tshwane University of Technology, the University of South Africa and the University of Pretoria. The conference website can be found at www.mlearn.org.za/

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MLEARN 2004 conference papers

Using learning theories to design instruction for mobile learning devices

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Abstract

Current instructional design models and methods were developed to design instruction for delivery on personal desktop computers that have large screens and are located in learners' homes or workplaces. However, there is a trend towards the use of mobile devices to deliver learning materials, and for students to learn anytime and anywhere. The use of mobile devices for learning has implications as to how learning materials are designed using learning theories and instructional design principles. This paper will describe learning theories and instructional design principles for the design of learning materials for mobile devices and the use of intelligent agents to customise learning materials for individual learners.

Keywords
instructional design, learning theories, mobile learning, mobile device, m-learning

1 Introduction

The growing use of wireless technology and mobile devices suggests that training and education cannot ignore the use of mobile devices in the learning/training process. An increasing number of workers are working outside the office and they will require just-in-time training wherever they are located. In the next two years, there will be more than 1bn subscribers to the wireless internet (Tirri 2003). Trainers and educators need to design learning materials for the growing use of mobile devices; however, the design of the materials must be based on sound learning theories and instructional design principles.

Sharples (2002) proposed a theory based on conversation for the design of mobile technology for learning. Roschelle and Pea (2002) suggested that wireless internet learning devices (WILD) could be used for computer-supported collaborative learning (CSCL) where the teacher becomes a guide or coach and learners take the initiative in their learning. They claimed that learning will become more learner-centered, rather than teacher-centered, which has implications for how instruction is designed for mobile devices. According to Tella (2003), mobile devices can be used to increase cognitive growth at the individual level, and an individual's motivation is enhanced when he or she is able to develop based on needs and context. Knowledge is information in context and knowledge creation is location-dependent and situation-dependent. Mobile learning devices allow learners to learn wherever they are located and in their personal context so that the learning is meaningful (Sharples 2000).

The use of mobile devices in learning is referred to as mobile learning (m-learning): this is the delivery of electronic learning (e-learning) materials on mobile devices such as personal digital assistants (PDAs), mobile phones, Tablet PCs, Pocket PCs, palmtop computers, etc. Quinn (2000) defined mobile learning as 'the intersection of mobile computing and E-learning: accessible resources wherever you are, strong search capabilities, rich interaction, powerful support for effective learning, and performance-based assessment. E-learning independent of location in time or space'. When designing learning materials for mobile devices, proper learning theories and instructional design principles must be used to meet learners' needs, and at the same time, help learners to achieve the desired learning outcomes. However, when designing materials for mobile devices, certain limitations must be kept in mind. Ahonen *et al.* (2003) reported on a study where a mobile device was used to deliver an electronic course. When asked about limitations related to the delivery, students mentioned the small screen size and problems in navigating within the lesson.

Because of the small screen size in mobile devices, the interface should be built in such a way to convey the message using the smallest amount of text, and proper navigation must be built into the system to allow learners to move between screens and sections of the lesson. Also, the interface must be appropriate for individual learners and the system should be able to customise the interface based on an individual learner's characteristics. The next sections of this paper suggest how to design learning materials for delivery on mobile devices.

2 Learning theories

Cognitive psychologists claim that learning involves the use of memory, motivation and thinking; and that reflection plays an important part in learning. They see learning as an internal process and suggest that the amount learned depends on the processing capacity of the learner, the amount of effort expended during the learning process, the depth of the processing (Craik and Lockhart 1972) and the learner's existing knowledge structure (Ausubel 1974). Paivio's theory of dual coding (1986) states that memory is enhanced when information is presented both in the verbal and visual form. According to constructivism, learners interpret the information and the world according to their personal reality; they learn by observation, processing and interpretation, and then personalise the information into personal knowledge (Cooper 1993). Learners learn best when they can contextualise what they learn, both for immediate application and to acquire personal meaning. Mobile learning facilitates personalised learning because learning (and collaboration) from any place and at any time allows the learning to be contextualised.

2.1 Learning principles for designing m-learning materials

Rather than presenting all of the available materials to learners, intelligent systems must be built to develop an initial profile of the learner and present materials that will benefit the specific learner. As the learning system interacts with the learners, it 'learns' about each student and adapts the interface and navigation pattern according to that learner's style and needs.

Because of the limited display capacity of m-learning devices, designers must use presentation strategies to enable learners to process the materials efficiently. Since working memory has limited capacity, information should be organised or 'chunked' into pieces of an appropriate size to facilitate processing. According to Miller (1956), because humans have limited short-term memory capacity, information should be grouped into meaningful sequences. Information to be displayed on m-learning devices should be chunked into between five and nine meaningful units to compensate for the limited capacity of short-term memory and the limitation of the display device.

Rather than being presented in a textual format, the information should be organised in the form of a concept map or a network that shows the important concepts and the relationship between the concepts. Networks can be used to represent information spatially so that students can see the main ideas and their relationships. Novak, Gowin and Johanse (1983) used a concept map to show the hierarchic structure of subject matter, similar to the way in which information is stored in long-term memory. In addition, as a learning strategy, learners can be asked to generate their own concept map on the mobile device. According to Stoyanova and Kommers (2002), concept map generation requires critical reflection and is a way of externalising the cognitive structure of learners' brains to facilitate deep processing. As a high-level collaborative activity, learners can be asked to work in virtual small groups to construct concept maps and review each other's maps.

Pre-instructional strategies should be used to allow learners to store the framework of the lesson: this will help them to incorporate the details of the lesson and to prevent information overload. This is critical for m-learning since information will be presented in pieces and learners will need to use the general framework to integrate the pieces. Mobile learning materials should use expository advance organisers to allow learners to store the general framework; and comparative advance organisers to allow them to use existing knowledge to make sense of and take in the new materials (Ausubel 1974; Ally 2004a).

The interface of the m-learning device must be designed properly to compensate for the small screen size of the display. The interface must be graphical and must present between five and nine chunks of information on the screen to prevent information overload in short-term memory. The interface is required to coordinate the interaction between the learner and the learning materials.

The system should contain intelligent agents to determine what the learner did in the past and adapt the interface for future interaction with the learning materials. The m-learning system must be proactive, anticipating what the learner will do next and providing the most appropriate interface for the interaction to enhance motivation and learning. For learning sessions that are information-intense, the system must adjust the interface to prevent information overload. Ways of doing this include presenting fewer concepts on one screen; or organising the information in the form of concept maps to give the overall structure of the information and then presenting the details. The interface must also use good navigational strategies to allow learners to move back and forth between displays. Navigation on m-learning devices should be automatic, based on the intelligence gathered on the learner's current progress and needs.

Learning materials for m-learning devices should take the form of learning objects which are in an electronic format and reusable (McGreal 2004). Learning materials should also be designed in the form of learning objects to accommodate different learning styles and characteristics. The objects are then tested and placed in an electronic repository for just-in-time access from anywhere using mobile devices. A course or lesson will comprise a number of learning objects which are sequenced to form an instructional event for a lesson or learning session (Ally 2004b). The use of learning objects allows for instant assembly of learning materials by learners, intelligent agents and instructors, which facilitates just-in-time learning and training.

3 Conclusion

Mobile learning devices can be used to deliver learning materials to students, but the materials must be designed properly to compensate for the small screen size of the devices. Learning materials need to use multimedia strategies that are information-rich rather than textual strategies. As a result, the writing style of course developers has to change from textual writing to a greater use of visuals, photographs, videos and audio. Intelligent agents should be used in m-learning systems so that most of the work is done behind the scene, minimising the input needed from learners and the amount of information presented on the display of the mobile devices.

References

Ahonen M, Joyce B, Leino M and Turunen H (2003). Mobile learning: a different viewpoint. In H Kynäslahti and P Seppälä (eds) *Professional mobile learning*. Helsinki: IT–Press, 29–39.

Ally M (2004a). Foundations of educational theory for online learning. In F Elloumi and T Anderson (eds) *Online learning handbook*. Athabasca: Athabasca University, 3–32.

Ally M (2004b). Designing effective learning objects for distance education. In R McGreal (ed.) *Online education using learning objects*. London: Routledge/Falmer, 87–97.

Ausubel DP (1974). *Educational psychology: a cognitive view*. New York: Holt, Rinehart and Winston.

Cooper PA (1993). Paradigm shifts in designing instruction: from behaviorism to cognitivism to constructivism. *Educational Technology*, 33(5), 12–19.

Craik FIM and Lockhart RS (1972). Levels of processing: a framework for memory research. *Journal of Verbal Learning and Verbal Behavior*, 11, 671–684.

McGreal R (2004). *Online education using learning objects*. London: Routledge/Falmer.

Miller GA (1956). The magical number seven, plus or minus two: some limits on our capacity for processing information. *Psychological Review*, 63, 81–97.

Novak JD, Gowin DB and Johanse GT (1983). The use of concept mapping and knowledge Vee mapping with junior high school science students. *Science Education*, 67, 625–645.

Paivio A (1986). *Mental representations: a dual coding approach*. Oxford: Oxford University Press.

Quinn C (2000). mLearning: mobile, wireless, in-your-pocket learning. *LineZine*. At www.linezine.com/2.1/features/cqmmwiyp.htm, accessed 19 June 2004.

Roschelle J and Pea R (2002). *A walk on the WILD side: how wireless handhelds may change computer-supported collaborative learning*. Paper presented at the International Conference on Computer-Supported Collaborative Learning (CSCL–02), Boulder, Colorado, 7–11 January.

Sharples M (2000). *The design of personal mobile technologies for lifelong learning*. Computers and Education, 34, 177–193.

Sharples M (2002). Disruptive devices: mobile technology for conversational learning. *International Journal of Continuing Engineering Education and Lifelong Learning*, 12(5/6), 504–520.

Stoyanova N and Kommers P (2002). Concept mapping as a medium of shared cognition in computer-supported collaborative problem-solving. *Journal of Interactive Learning Research*, 13(1/2), 111–133.

Tella S (2003). M-learning – cybertextual travelling or a herald of post-modern education. In H Kynäslahti and P Seppälä (eds) *Mobile learning*. Helsinki: IT–Press, 7–21.

Thornton P and Houser C (2004). Using mobile phones in education. In *Proceedings of the 2nd IEEE International Workshop on Wireless and Mobile Technologies in Education*, Taiwan, March 2004, 3–10.

Tirri H (2003). Promises and challenges of mobile learning. In H Kynäslahti and P Seppälä (eds) *Mobile learning*. Helsinki: IT–Press, 23–28.

JELD, the Java Environment for Learning Design

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Abstract

In this paper we present JELD, the Java Environment for Learning Design, an online distance learning system designed to implement different kinds of approach to learning. The system is a Java 2 Enterprise Edition that supports pedagogical diversity and innovation. JELD allows users to define teaching strategies, pedagogical approaches and educational goals using the IMS Learning Design Specification. At the moment, the system uses a subset of IMS Learning Design Specification that allows a knowledge-building process to be run in a collaborative learning environment. Moreover, JELD can adapt learning activities to the client device; in particular, we have developed modules for PCs, personal digital assistants (PDAs) and mobile telephones.

Keywords
learning design, learning methodologies, collaborative learning, standards, mobile learning

1 Introduction

Over the last few years, many research studies about learning standards have been carried out, most of them concerning metadata definitions of learning content such as IEEE WG12 (2002) and ADL Technical Team (2001), but few of them have been about learning processes. Except for a few rare cases, the learning platforms developed conformed only to the content standards. Besides, in most cases, a learning platform dealt with a single pedagogical approach without considering the interoperability of learning processes among platforms. Recently, some studies have been carried out regarding learning processes (Koper 2001).

In this context, learning design (IMS 2003) represents one of the most significant developments in e-learning (Dalziel 2003). Learning design (LD) aims to define all the features of the learning process, such as teaching strategies, pedagogical approaches, educational goals, activities and services.
Our system aims to contribute to this topic.

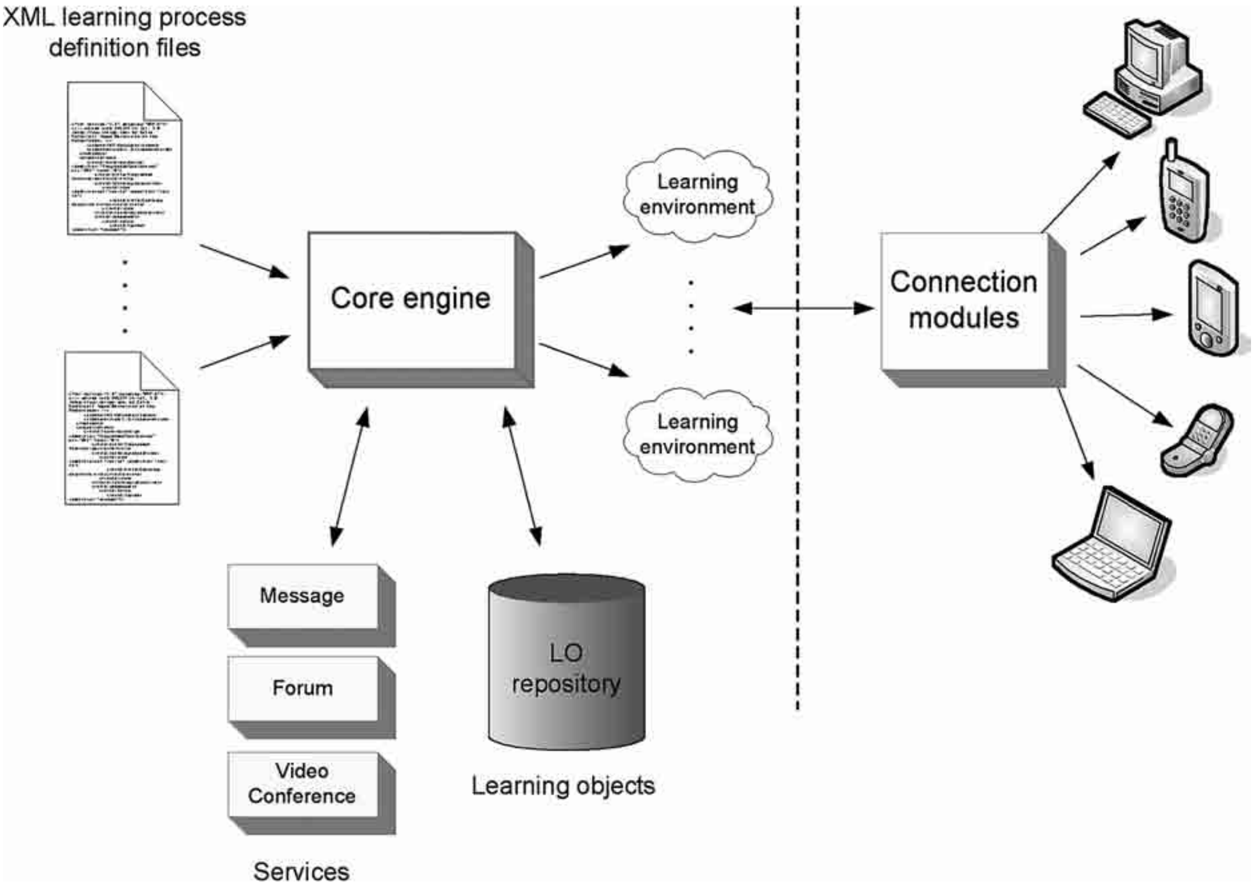
2 Framework architecture

As shown in **Figure 1** (overleaf), the framework consists of a core engine for running a learning process, a number of service modules and some connection modules.

The core engine receives an Extensible Markup Language (XML) LD document as input and produces a runtime instance of a learning environment ready to be delivered to users. This process follows three main steps: validation, environment set-up and runtime creation. In the validation step, according to the IMS guidelines, the core engine checks the references, semantics and completeness of the input document. Then a set of objects (Enterprise Java Beans) are instanced to set up the environment. Finally, the runtime environment is created, with the services, learning objects and user profiles defined in the input LD document. At the moment, the system uses a subset of IMS Learning Design Specification that allows a knowledge-building process to be run in a collaborative learning environment. A set of modules is used to provide all the services needed in runtime; for example, the message exchange module is used to send e-mails and/or Short Message System (SMS) between users.

Moreover, the interface of the learning runtime environment is adapted to the device using the connection modules. We have developed PC, PDA and mobile telephone modules. A difficulty in making content available for use by several types of device derives from the available hardware resources (the devices' limited display capability, network bandwidth, etc). Technologies used by JELD provide Extensible HyperText Markup Language (XHTML) and XML Forms (XFORMS) interfaces to adapt information to the student client. Using XHTML, we share basic content across desktops, PDAs and mobile phones.

Figure 1 JELD architecture



3 A learning design case study: collaborative knowledge building

At present, we have implemented a collaborative knowledge-building case study. In this case-study scenario, the actors involved are a teacher and a group of students. The teacher can define a knowledge type set that is the list of artefacts used by the students in the knowledge-building process (Scardamalia and Bereiter 1994). According to Leinonen *et al*. (2002), the knowledge type set of progress enquiry uses the following artefact: discovery of key ideas in knowledge building. After this phase, the teacher must define the logical dependences among the artefacts that guide the building path. The teacher starts the activities by defining a context course in which the users are invited to insert their artefacts according to the context schema.

References

ADL Technical Team (2001). *SCORM Specification v1.2*. At www.adlnet.org/Scorm, accessed October 2001.

Dalziel J (2003). Implementing learning design: the Learning Activity Management System (LAMS). In *Proceedings of the 20th Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education (ASCILITE), Adelaide, 7–10 December*, 593–596.

IEEE WG12 (2002). *Standard for learning object metadata*. At http://ltsc.ieee.org/wg12, accessed June 2002.

IMS (2003). IMS *Learning Design Specification v1.0*. At www.imsglobal.org/learningdesign/index.cfm, accessed 30 July 2003.

Koper R (2001). *Modelling units of study from a pedagogical perspective: the pedagogical meta-model behind EML*. Educational Technology Expertise Centre, Open University of the Netherlands. At http://eml.ou.nl/introduction/articles.htm, accessed October 2001.

Leinonen T, Virtanen O, Hakkarainen K and Kligyte G (2002). Collaborative discovering of key ideas in knowledge building. In *Proceedings of the Conference on Computer Support for Collaborative Learning, Boulder, Colorado, 7–11 January*, 529–530.

Scardamalia M and Bereiter C (1994). Computer support for knowledge-building communities. *The Journal of the Learning Sciences*, 3, 265–283.

mCLT: an application for collaborative learning on a mobile telephone

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Abstract

Mobile technologies offer new opportunities for distance learning and enable people to collaborate anywhere. This paper introduces an innovative mobile platform for computer-supported collaborative learning in which traditional methodologies of collaboration have been improved, based on 3rd-generation mobile telephones. Students can collect and share live data immediately, anywhere and at any time. This enables them to play an active role in the knowledge-building process. The mCLT is potentially an application for ubiquitous collaborative learning.

Keywords
collaborative learning, mobile computing

1 Introduction

Cooperation between an individual and a group, between people and an organisation, between theoretical and practical education are only some examples of collaborative learning. Most studies on collaborative learning have been carried out in the last decade and they have proposed different meanings of 'learning'. Watanabe and Kojiri have suggested different kinds of educational support system, such as computer-assisted instruction (CAI), computer-aided learning (CAL), intelligent tutor system (ITS) and computer-supported collaborative learning (CSCL), in which learners are able to freely change their learning style (Kojiri and Watanabe 2001; Watanabe 2001). Fischer's Lifelong Learning system (2000) allows learning space to be rearranged using information technology (IT); in this sense, learning activities can be seen as a practical workspace changing over a long period. Other studies look at the standardisation of collaborative learning. Okamoto, Kayama and Cristea (2001) have planned a standardisation of collaborative learning based on six essential structural elements:

- collaborative learning environment expression
- collaborative workspace expression
- collaborative learning resources expression
- collaborative workplace expression
- learner group model in collaborative learning
- collaborative memory structure expression.

Our paper focuses attention on the *collaborative workspace expression* because one of the major advantages of using mobile devices for online learning is the benefit they offer to cooperation – working together to accomplish shared goals. Within cooperative activities, individuals seek outcomes that are beneficial to themselves and beneficial to all other group members. Cooperative learning is the use of small groups for instructional purposes so that participants work together to maximise their own and each others' learning (Johnson, Johnson and Smith 1991).

The mobile Collaborative Learning Tool (mCLT) can be seen as an extension of the Java Environment for Learning Design (JELD) system developed in the Italian National Research Council's Institute for Education Technology in Palermo (JELD 2005). The JELD system allows the teacher to design the learning process using a direct graph model. The nodes represent the knowledge types (eg problem, comment, working theory) and the edges are relationships between them. The students participate in the learning activities, inserting notes according to the learning graph rules.

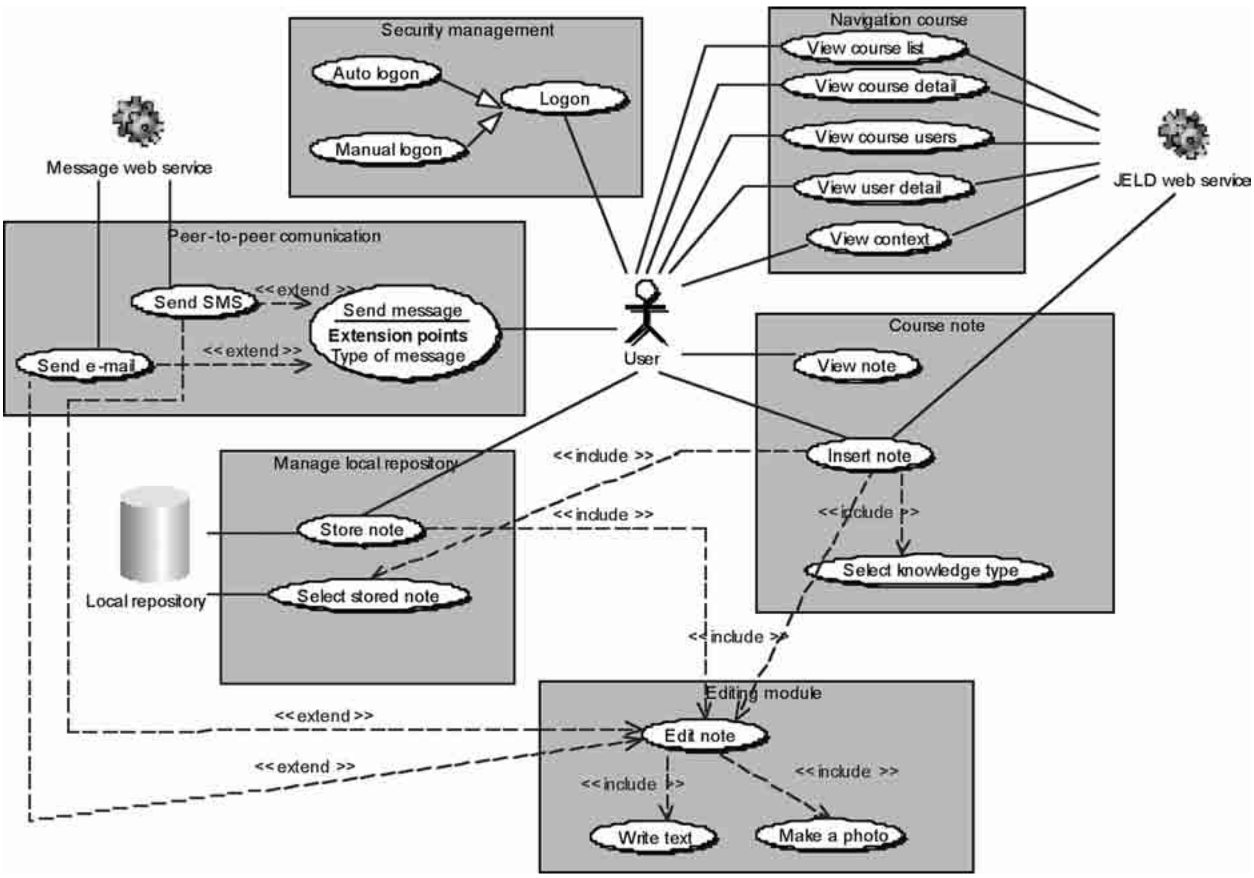
The mCLT is potentially an application for ubiquitous collaborative learning. The most innovative aspect of the mCLT application is that the students, using a mobile device, can play an active role in the knowledge-building process, anywhere and at any time.

2 Application architecture

The mCLT system is a Java™ Mobile Information Device Profile (MIDP) client for mobile telephones, designed for collaborative learning and knowledge sharing among online educational communities. **Figure 1** shows the functional modules of the system. It is characterised by a set of web services hosted on the server side and six mobile client modules. Each module uses a Simple Object Access Protocol (SOAP) to interact with the web services; and to manage the logon phases, a Security Management module has been inserted to administer the security aspect of the system. Automatic logon is performed using the latest access information stored in the local repository of the learners' mobile devices. Security Management also guarantees that communication with the server through the web services is encrypted, using a lightweight implementation of the Advanced Encryption Standard (AES) algorithm.

The Navigation Course module was developed to manage a number of course activities. This allows students to browse the list of courses, and to look for detailed information about each course, the participants and the list of contexts (areas for online discussion). The Course Note module is used to visualise, select and publish the students' notes, and it allows users to reply to notes or add new notes with images already stored in the local repository. To create and modify notes, a student uses the Editing Module. With the current version of the system, it is only possible to insert static images into notes. Communication between students is performed by the Peer-to-Peer Communication module which uses a message-system web service to send e-mails and Short Message System (SMS). Finally, a Manage Local Repository module has been defined in the system; this module allows users to work in offline modality and to arrange and store notes and images. The images can be acquired from a photo camera embedded in the learner's mobile device. All of the objects stored in the local repository can be used to create new messages or notes in the online sessions.

Figure 1 mCLT use case view



3 Scenario

The first step in using the mCLT system is the installation phase. The MIDLet suite can be delivered to Java to Mobile Edition (J2ME) devices by the Over-the-Air (OTA) system of the JELD platform. Following the installation, a user can manage the local repository which can be seen as a memory area in the mobile device. The user can store offline notes, photos and other sets of knowledge as in a personal desktop.

When a user has logged onto the system, the list of subscribed courses will be shown and he/she can select a course and view the contexts of the course. Each context is a discussion on a topic with a specific learning graph model, which is opened by the course author. In many respects, the context is like a thread in a discussion forum, but the use of metacognition identifiers (eg in the progressive enquiry process: problem, comment, working theory, etc) makes it easy for the students to distinguish the key concepts in the discussion. In this manner, the system increases the participants' awareness of their fellow students' thinking (Leinonen *et al*. 2002) and allows them to play an active role in the knowledge-building process, replying to any note of interest with a new note. The user could add a new note according to the learning graph rules of the specific context; in fact, a note is a portion of knowledge such as a text and/or photos marked with a metacognition identifier called 'knowledge type'.

The users collaborate in building knowledge and new theories (Scardamalia and Bereiter 1994) anywhere and at any time, using the features of 3rd-generation mobile telephones. Indeed, the users can insert contents such as photos and videos, directly acquired through the mobile phone, into the discussion threads. In this way, the discussion is enriched by the multimedia and mobility functions of 3rd-generation mobile phones.

4 Conclusion and ongoing work

The application described in this paper should be considered as a contribution to ubiquitous collaborative learning. The mCLT allows students to participate in a knowledge-building process. The students interact among themselves, following the model defined by the teacher.

A phase of testing prior to deployment has been started, using an application prototype. The mCLT has been tested with five users from the CNR Institute for Education Technology in Palermo, using three Java-compliant mobile telephones (MIDP 1.0 with Mobile Media Application Programming Interface) and two personal digital assistants (PDAs) with the Java Personal Edition.

The results collected in this phase have been used to improve the functionality of the system and to correct some application bugs. When the alpha version of the mCLT is ready, the plan is to start the online experimentation in a real university course. Fifty students will be involved in this phase to test the application using several types of mobile device.

References

Fischer G (2000). Lifelong learning – more than training. *Journal of Interactive Learning Research*, 11(3/4), 265–294. (Special issue on intelligent systems/tools in training and lifelong learning, edited by R Mizoguchi and PAM Kommers).

JELD (2005). *Website*. At www.pa.itd.cnr.it/jeld/

Johnson DW, Johnson RT and Smith K (1991). *Active learning: cooperation in the college classroom*. Edina, MN: Interaction Book Company.

Kojiri T and Watanabe T (2001). HARMONY: web-based adaptive collaborative learning environment. In *Proceedings of the Ninth International Conference on Computers in Education, Seoul, 12–15 November*, 559–566.

Leinonen T, Virtanen O, Hakkarainen K and Kligyte G (2002). Collaborative discovering of key ideas in knowledge building. In *Proceedings of the Computer Support for Collaborative Learning Conference. Boulder, Colorado, 7–11 January*, 529–530.

Okamoto T, Kayama M and Cristea A (2001). Proposal of a collaborative learning standardization. In *Proceedings of the IEEE International Conference on Advanced Learning Technologies, Madison, Wisconsin, 6–8 August*, 267–268.

Scardamalia M and Bereiter C (1994). Computer support for knowledge-building communities. *The Journal of the Learning Sciences*, 3, 265–283.

Watanabe T (2001). Knowledge management architecture of integrated educational support. In *Proceedings of the Ninth International Conference on Computers in Education, Seoul, 12–15 November*, 1138–1141.

Engaging and supporting mobile learners

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Abstract

This paper describes the learner research and systems trials phase of the m-learning project and the emerging findings. This phase of the project took place between February and July 2004 and involved nearly 300 learners using Smartphones and PDA/phone hybrids to access the learning materials and systems developed within the project.

The research and trials explored learners' and mentors' reactions to and experiences with the devices, learning materials and systems; and explored whether m-learning can: engage reluctant young learners in education or training; and deliver learning and/or more enthusiasm for learning. Appropriate and effective ways of providing pedagogic support and scaffolding were also explored.

Keywords
mobile learning, inclusion, widening participation, literacy, numeracy, basic skills, mentoring

1 The m-learning project

The m-learning project is a 3-year pan-European collaborative research and development (R&D) programme supported by the European Union (EU). The consortium is a partnership of organisations combining skills in pedagogy and technology. It includes two university-based research units [Ultralab at Anglia Polytechnic University (APU) in the UK and Centro di Ricerca in Matematica Pura et Applicata (CRMPA) at the University of Salerno in Italy]; two commercial companies [Cambridge Training and Development (CTAD) in the UK and Lecando in Sweden]; and an independent not-for-profit national educational research and development (R&D) agency [the Learning and Skills Development Agency (LSDA)] in the UK.

The project has developed prototype products and innovative approaches designed to support learning – particularly literacy, numeracy and life and survival skills – using handheld devices such as mobile phones and palmtop computers or pocket computers. A key objective is to engage with and motivate young adults who are not taking part in education or training, including those who are unemployed, homeless or disadvantaged.

2 The learner research and system trials

2.1 Guiding principles and research questions

The work of the m-learning project is guided by the partners' shared belief in the following propositions.

- The fact that many young adults have poor literacy and numeracy skills (Moser 1999) and little or no interest in education and training (DfEE 2001) is both a personal tragedy and a waste of potentially valuable national and European resources.
- Learning is a natural human activity that most people will engage in if given the right encouragement.
- Many young people tend to be excited by, and interested in, new technologies.
- Learning mediated by technology can provide a convenient, personalised and non-judgemental alternative to traditional education.

In this phase of the m-learning project we have been addressing three overarching research questions.

- Can the enthusiasm of many young adults for mobile phones and other portable communications and entertainment devices be harnessed to encourage those not currently engaged in education or training to take part in learning experiences?
- Can m-learning result in improved literacy or numeracy skills or in changes in attitude or behaviour, including greater enthusiasm for learning and/or progression to further learning?
- What kind of pedagogical support and scaffolding do m-learners need? How can this be provided?

2.2 Collaborating organisations and learners

The m-learning partners have recruited 14 organisations to collaborate in this phase of the project. They all have existing support and mentoring relationships with groups of young adults in our target audience. Together they have recruited nearly 300 young people to take part in our research. The table in **Figure 1** summarises the collaborating organisations and the type of young people they support.

2.3 Selecting the mobile devices

Figure 2
The mobile devices

P800 P900 XDA II

In selecting the equipment, we tried to avoid the project findings becoming out of date too soon and to anticipate the technologies that would be readily available to the target audience after the end of R&D – that is, from 2005. The project partners developed a ‘road map’ charting our analysis of current and predicted technologies and functionality throughout the project and projecting their likely future relevance to the project. Consideration was given to:

Figure 1 Collaborating organisations

Organisation	Types of learner
Project Milford, Wales	Disadvantaged, including unemployed
Foyer Federation	Homeless
Hartpury College	Modern Apprentices
Yaa Asantewaa Arts and Community Centre	Afro-Caribbean young people not interested in learning
ContinYou	Family learning including young fathers
Plymouth Learning and Work Partnership	Mostly unemployed, disadvantaged
Kent Adult Education	Travellers, homeless, young offenders, young mothers
Avon Consortium Traveller Education Service	Travellers
City College Norwich	Reluctant students
Highland Council, Scotland	Unemployed, homeless, travellers, young offenders
Weston College	Work-based learners/Modern Apprentices
City of Stockholm Schools	School pupils including potential drop-outs
Mentoring USA/Italia, Salerno	Disadvantaged youth
Albatros, Napoli	Immigrants and dialect speakers

- delivery options (eg WAP, e-mail, SMS, MMS, HTTP)
- platform options (eg Pocket PC, Symbian, Windows CE, J2ME)
- media options (eg video, audio files, phone calls, teleconferencing, voice recognition)
- development languages (eg Flash, C#, WML, VoiceXML, HTML, XHTML)
- transport options (eg GPRS, 3G, downloading, infrared, Bluetooth).

As the start of the learner research and systems trials approached, we selected and acquired nearly 100 devices including SonyEricsson P800 and P900 Smartphones and O_2 XDAII PDA/phone hybrids (see **Figure 2** opposite).

2.4 The learning materials and systems

The learning materials developed include:

- smaller-than-bite-sized literacy, numeracy and life skills modules available both offline (downloaded to the XDA II) or online via the web browser and the learning management system (LMS)
- driving theory test quizzes, which are Java-based and can be downloaded to mobile phones which support JAVA (including the P800 and P900)
- SMS quizzes linked to text-based materials and a mini-SMS language course (basic Italian)
- a mini web-page builder.

The ‘back office’ systems include a portal, a LMS and an intelligent tutor providing services including access to relevant links and materials, course building, chat, discussion and web logs (blogs).

2.5 The research approach

Our research explores the general hypotheses that handheld devices can be used for learning and that m-learning can attract young people who do not enjoy traditional education. As both the concept and the practice of m-learning are still very new, our research largely focuses on the exploration of information gathered and further development of hypotheses, rather than on proving pre-existing theories. However, where sufficient common positive messages arise from several small groups, we hope this may provide enough evidence to persuade funding bodies to support roll-out of m-learning services to larger populations.

When we have analysed more of the data we have collected, we would like to be able to report some concrete outcomes; for example, that the literacy or numeracy of some of the learners has improved. However, this is difficult as none of the learners will be m-learning for a very long period. The period of involvement for collaborating organisations varies from 3 to 9 weeks. Also, it has been observed that ‘It is often both unlikely and inappropriate for many projects to expect to achieve “hard” outcomes from target groups that are socially excluded and facing multiple barriers to employment.’ (Dewson *et al*. 2000). We are therefore seeking ‘soft’ as well as ‘hard’ outcomes from our research, including indications of a change in attitude – learners exhibiting apparently increased levels of enthusiasm or confidence. We are also particularly interested to find out whether some of the young people who have taken part in our m-learning research later register to take part in further e-learning.

We have collected information from several sources to allow triangulation. Sources include information on the young adults via intermediaries who have an existing relationship and credibility with them; and electronic services. Data collection is summarised in **Figure 3** (overleaf). We felt it was important that the young people involved did not see the activities they were involved in as just another lesson, or themselves as simply ‘guinea pigs’. Therefore we recommended to the mentors that when they introduced the project, they emphasised that it is about helping us to try out the mobile devices, find out how good they are, discover any problems and find out if they might be useful to help other young people to learn. For this reason, we referred to the young people as research assistants (RAs) rather than learners or users.

Figure 3 Data collection

Source: coordinator

- Project plan including objectives for the organisation, mentors and research assistants (RAs)
- End-of-project form inviting reflection on experiences and results

Source: mentors

- Start-of-project questionnaire including prior experience, expectations and objectives
- End-of-project questionnaire inviting reflection on experiences and results
- Face-to-face or telephone interview exploring experiences, issues, outcomes, future plans
- Start- and end-of-project assessment forms describing each RA

Source: research assistants (RAs)

- Start-of-project interview with mentor
- End-of-project interview with mentor
- Direct messages to the project team posted onto mediaboard or via microportal

Source: systems

- Information about time and duration of access to online materials and systems
- Number and duration/size of phone calls, SMS and MMS messages

2.6 Emerging findings

Although we are at a very early stage of data collection and analysis, there are some reports emerging of positive outcomes for young adults involved. One mentor has been working with a homeless young adult who regularly truanted while at school and subsequently left school without any qualifications. The mentor reports that as a result of participation in the m-learning project, her client has not only developed a greater confidence in his current reading and writing abilities, but he has also been inspired to seek help to improve his mathematical skills from the local Adult Basic Education Centre.

Another mentor, working with a group of displaced young adults studying ESOL (English for Speakers of Other Languages), reports that a number of learners who had previously avoided using PCs seem much more confident about using technology since taking part in the m-learning project and have begun to use PCs to work on tasks such as writing letters. One mentor noticed that learners were more focused for longer periods when involved in m-learning, compared with traditional classroom lessons. The mentor told our researcher: 'The group were observed to be remarkably focused and calm during the session when [they were] given the devices, in contrast to their normal behaviour in the sessions. They were far more focused and gave up to 2 hours of time to the devices when it is normally difficult to focus them for 15 minutes.'

Another mentor believed that 'the devices are good tools to engage non-traditional learners, they remove the formality, which can be the most frightening aspect for those who have not engaged with learning' and reported that the use of the mobiles has improved retention of learners on their course.

It is possible that some of these effects are due to the novelty of using mobile devices and whether this is the case or not will become clearer over time.

Some positive outcomes not directly related to learning have also been reported. Some of the learners were surprised and proud to be trusted with such expensive and sophisticated technology; for example, one project mentor noted: 'He took really good care of it. He pointed out that because of his background, no one else would have ever trusted him with a mobile. This has meant more to him than the actual device itself as he feels respected.'

This finding is consistent with earlier research projects involving laptop computers where researchers have found that the loan of portable technology causes positive effects, such as increased motivation, to be felt also in children's lives outside school, resulting in improved confidence, motivation and self-esteem for disaffected pupils and those with learning difficulties or disabilities (eg Passey 1999).

When we first discussed with collaborating organisations the plan of lending the mobile devices to learners and allowing them to take these away from a classroom or centre, some expressed concerns about possible damage or theft, excessive or inappropriate use and/or increased likelihood of mugging. The project team felt, based on the encouraging evidence from previous projects, that with some warnings and small safeguards, we should take the risk. Experience to date suggests that this was the right approach. We have had very little loss or damage – one XDA has been damaged (someone sat on it!) and two XDAs have been lost or stolen, representing only 3% of our devices. There has been some excessive use for non-project activities, causing us temporarily to block phones and issue warnings, which have resulted in improved behaviour; and only one reported incident of inappropriate use of the internet.

2.7 Equipment and service issues

Although our experience was not quite as bad as that of Luckin *et al*. (2004) who found that 'an enormous amount of time was spent maintaining the devices (*older model* XDAs) in full working order', providing first-line support to our mentors and learners has not been a simple task. Providing support has been complex, as learners and mentors are inexperienced users of such sophisticated mobiles and because problems experienced can be connected with one or more of the following: device hardware or native software; the signal (or lack of signal) in the area of use; third-party software, such as Flash, which we have loaded onto the devices; software developed within the project by three different partners; learner misuse – for example, changing settings or deleting software.

To date, handheld devices – and particularly mobile phones – have been mostly sold for individual rather than project or institutional use: as a result, support from suppliers and service providers is underdeveloped. For example, the website which allows us to monitor the use of the mobiles is not updated in real time and has to be searched by individual mobile phone number – a very time-consuming task. It has also proved much more difficult (and slower) than expected to implement restrictions on user activities; for example, blocking of premium-rate telephone numbers.

References

Moser C (1999). *Improving literacy and numeracy: a fresh start*, Sudbury: Department for Education and Employment.

Dewson S, Eccles J, Tackey ND and Jackson A (2000). *Measuring soft outcomes and distance travelled: a review of current practice*. London: Department for Education and Employment.

DfEE (2001). *Skills for life: the national strategy for improving adult literacy and numeracy skills*. Nottingham: Department for Education and Employment.

Luckin R, Brewster D, Pearce D, Siddons-Corby R and du Boulay B (2004). SMILE: the creation of space for interaction through blended digital technology. In J Attewell and C Savill-Smith (eds) *Learning with mobile devices: research and development*. London: Learning and Skills Development Agency, 87.

Passey D (1999). *Anytime, anywhere learning project evaluation*. Lancaster: Lancaster University/AAL.

Mobile learning in the retail trade: TransmobiLE (EU-funded Leonardo da Vinci II pilot project)

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Abstract

This paper introduces an adaptive learning and teaching environment for the use of mobile handheld computers in the retail trade. Students and employees learn with personal digital assistants (PDAs) how to offer, for example, 'cross-selling' and 'up-selling' opportunities to the customer or perform a convenient checkout. A collaborative mobile learning environment at the point of activity – on the sales floor – enables learners to improve their competences on an individual basis. Learner-centred teaching and learning arrangements (content) are being developed for food and lifestyle articles.

Keywords
retail trade, point of activity, teaching materials, PDA

1 Introduction

TransmobiLE is an EU-funded transnational pilot project for the integration of mobile learning into vocational education and continuing training in the retail trade.

This project focuses on didactical-methodical innovative teaching and learning arrangements (content) (Achtenhagen *et al*. 1992). It started on 1 October 2003 and will be finished on 31 March 2006.

2 Project targets

One project target is the design of learner-centred learning/teaching arrangements for mobile terminals within the mobile broadband network, customised for the needs of individual learners in the retail trade according to academically based construction criteria (see the teaching/learning matrix in Barth and Warneke 2004).

Another project target is the development of a certification concept for the retail trade, to enable the identification, assessment and recognition of competences acquired in formal, non-formal and informal ways.

3 Technical standards in the project

Students and employees learn with PDAs and mobile computers of industrial standard for the retail trade. These mobile devices, expanded with a 512MB secure digital (SD) card, are used in a wireless local area network (WLAN) with internet connection in the store.

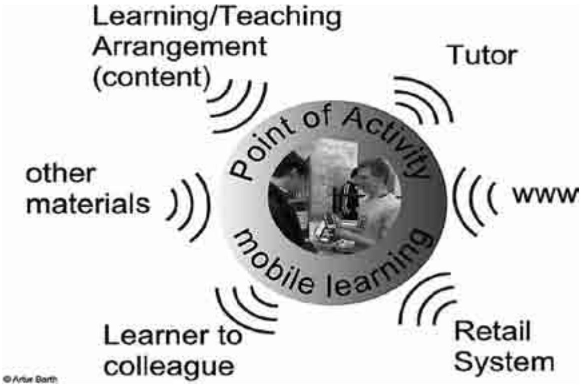
The multimedia content of the learning and teaching arrangements is designed using MS Mobile Office, Portable Document Format (PDF) and HyperText Markup Language (HTML) files and Flash format.

4 Teaching and learning architecture

The TransmobiLE teaching and learning architecture (Rosenberg 2001) is divided into periods of learning and training at different locations. The first period starts in the classroom of a college or a training centre where the learners are made familiar with the use of the mobile devices and the content of the learning arrangements.

The next period consists of mobile learning with these arrangements on the selling floor, at the point of activity (POA).

Figure 1
Mobile learning at the point of activity (POA)

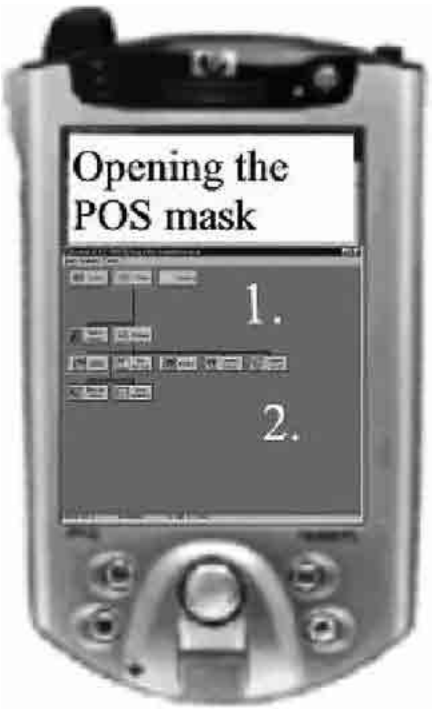


5 Mobile learning at the point of activity

Learners can get the information they require wirelessly and use it at the POA (see **Figure 1**). It enables them to offer 'cross-selling' and 'up-selling' opportunities to the customer, while at the same time they improve their competences.

An example of the teaching/learning arrangements (content) is the development of a user's manual for the POS (point of sale), based on the retail system in use, that can be run on an iPAQ 5550 Series or similar device. This guarantees instant access to learning content and provides the learner with a product that complements e-learning and classroom-based training.

Figure 2
Online help for the POS system



References

Achtenhagen F *et al.* (1992). *Lernhandeln in komplexen Situationen. Neue Konzepte der betriebswirtschaftlichen Ausbildung.* Wiesbaden: Gabler.

Barth A and Warneke P (2004). *Fit for e-commerce.* Rinteln: Merkur Verlag Rinteln.

Rosenberg MJ (2001). *e-learning strategies for delivering knowledge in the digital age.* New York: McGraw–Hill.

Wireless learning community hub

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Extended abstract

Keywords
community, internet, mobile, shared spaces

Community and communication in the 21st century

It is often argued that in everyday society our sense of community is being eroded. This is particularly relevant for learners, who may find that they have fewer opportunities to interact with colleagues and so become isolated in their learning activities. While it may be true that fewer people spend time chatting on street corners or in coffee rooms, the decline of human interaction is overstated since they have often shifted their communication to digitally enabled routes. Many people make extensive use of the internet, with the use of e-mail and instant messaging growing all the time, while mobile phone usage for both voice and text is also on the increase. Wireless networks are enabling people to read and reply to their e-mails while sitting in the bar or a coffee shop, and you can check on your team's latest result on your mobile phone.

The decline of physical communities is complemented by the increase of internet-enabled communities (Preece 2000), using functionalities ranging from chat rooms and bulletin boards to blogs (web logs) and shared photographs. Although Nielsen (1997) has argued that web users, in particular, have different goals, and thus do not often produce worthwhile content, some of these communities are exceptionally popular. Slashdot (2005) is a well-known computer and technology news forum, finding articles and new ideas that interest its 330,000 daily readers. It is well known for its ability to completely overwhelm other websites with the traffic it can create – but its real strength is in the commenting features that it has. Each story begins as the nub of a thread as on a discussion board, to which its army of users can offer their opinion. To try to eliminate off-topic conversations, Slashdot lets users moderate themselves – points are assigned on various criteria, and only the highest scores are shown. These communities show that sharing opinions and viewpoints online is exceptionally popular.

Internet learning communities

Many learning opportunities are guided or managed through the internet – e-learning platforms, blogs, wikis (software that allows web-page creation/editing without use of a browser) and websites – and so there is a growing body of learners who are familiar with these approaches. However, most of these systems use only one technological method – the Web or e-mail or SMS – to develop their communities. For many people, what is required is the digital equivalent of the street corner – where people can come and go; requiring little knowledge to participate in; and where people can learn and gain support and advice from their colleagues.

Wireless learning community hub

This project ties these issues and technologies together to create a community system so that people can continue to communicate wherever and however they want to, without fear of being bombarded with useless or offensive messages. An easy-to-use and clear interface is provided so new users can instantly get involved. The core system collates the messages and presents the information in a variety of ways. For a communal space, a message board containing the current stories, comments, notes and images is projected onto a wall, providing a large shared area with which co-located users can react.

With an uncluttered design, it is easy to scan and read updated information that is being submitted by other users, especially as the system learns exactly what interests the community. By monitoring the messages that are commented on, and analysing the contents of other messages, it builds up a statistical model of the relevance and interest each message has (Beale 2004). It uses this information to order the messages, and promotes the most interesting ones to the top. By promoting these stories to a prominent position, the user becomes more productive since less time is wasted trying to determine what is important. This also has the advantage that spam and unwanted messages quickly disappear off the display, actioned for dismissal by community consensus, not by administrative intervention. Interesting stories or comments can be commented on, increasing the sense of community interaction. Files such as pictures or documents can be attached to a message, making it possible to collaborate on work.

As well as a central display, the system supports other displays, so that being co-located is not a necessity. Users can receive information on their mobile phones, on Tablet PCs and laptops, and on personal digital assistants (PDAs). Contributions to the system can be made via a range of devices and technologies: users can post information to the system via their internet browser, via a wireless connection, or through SMS, and can be physically co-located or geographically separated. The questions, messages and stories are shared over a network of computers, allowing quick information exchange between users. Using the Simple Object Access Protocol (SOAP), which is a reliable and compatible communication protocol, it enables other implementations or even completely different products to join the network and share information. By using an extensible format, new features can easily be added without destroying backwards compatibility.

The system has been trialled within a university environment and informally evaluated by third-year and second-year students. Assessing it in terms of accessibility and usability, it scored highly, owing to the clean design and the ability to access it via whatever device came to hand, be it mobile phone, laptop or while sitting in the lab in front of a computer screen. The automatic ranking of stories was felt to be useful, though a larger community of users would give a less eclectic profile of interesting stories and would tend to produce a more consistent and comprehensible ranking. Users felt the system would be useful to support supplementary questions in their learning process and to expand their horizons, so that they could be made more aware of real-world examples of whatever issues were currently topical in lectures. However, without some form of structure and specific educational support, many felt that there was less use for the system in supporting formal learning than there was in supporting informal learning – where it offered an interesting forum in which to ask questions, tapping into the wide experience and backgrounds of the student community.

In the future, we hope to trial the system for a long period and analyse both the frequency and styles of use, to validate the informal reactions and findings reported above.

References

Beale R (2004). Improving internet interaction: from theory to practice. *JASIST* (Special issue on best practices and future visions for search user Interfaces).

Nielsen J (1997). *Community is dead; long live mega-collaboration*. At www.useit.com/alertbox/9708b.html

Preece J (2000). *Online communities: designing usability and supporting sociabilty*, 1st edn. New York: John Wiley and Sons, Inc.

Slashdot (2005). *Website*. At http://slashdot.org/

Integrating situated interaction with mobile awareness

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Abstract

This paper describes the design and implementation of an intelligent messaging system to allow students and lecturers to communicate better with each other when office-based interactions fail.

Keywords
intelligent messaging, Short Messaging System (SMS), situated interaction

Overview

A common problem for many learning organisations is the lack of any formal method to contact staff members rapidly without the disclosure of potentially personal information, such as mobile phone numbers. One 'traditional' method of interaction existing between staff and students involves the sticking of notes on office doors. Lecturers wanting to leave a message on their office door from a remote location often require the help of another member of staff, such as a receptionist, who might put up a note on their behalf. This method has worked for a long time, but there are intrinsic issues relating to a lack of security and privacy, and the practical problems of notes falling off doors or a lack of timeliness in posting the note.

To address these issues, a system has been designed and implemented that uses mobile and other technologies to provide an increased level of interaction between staff and students. The primary focus was on creating a system based on the concept of 'situated interaction' (Streitz *et al*. 2003) in an attempt to bridge the gap that currently exists between the learner and the instructor, and to allow an increased degree of mobility and remote accessibility necessary for modern learning situations.

The system, named IMMS (Intelligent Mobile Messaging System), involves the placement of a number of display units on the office doors of various members of staff in the department, acting as information and messaging terminals for students. These units are iPAQs or similar handheld devices. Members of staff may write a message and have a picture displayed on the unit; the content displayed on the units is set by the owner of the unit via a remote-access web-based management system. For staff users who do not have the time or opportunity to sit down at a computer and log into the management system, an SMS-based system is available, allowing users to update their display unit content by sending a text message from their mobile phone to the IMMS server. This may be of significant use to staff members who have a great many department-based commitments, but are frequently away from the department for whatever reason. For example, staff members can update the display to inform scheduled visitors that they will be late because they are stuck in traffic.

Student members of the department are not only able to view the image and the textual message set by the owner of the unit, but are also able to send messages to the owner via the display-unit interface. A student calling in to see a lecturer and finding an empty office may use the web-based interface on the display unit to compose a short message and mark it urgent or non-urgent. In the case of an urgent message, composed by students, other departmental members or visitors, IMMS will either send the information via text message to the unit owner's mobile phone or store the message in the management system for display next time the IMMS user logs into the system. The routing of the messages sent via the display unit depends on the configuration settings prescribed in the personal profile of the user.

This intelligent routing of messages extends similar work on situated door displays by Cheverst *et al*. (2002) which had non-intelligent SMS notification.

The web-based components of the system offer configuration and message management, and also allow remote access to the information presented on the screen, allowing users on the internet to look up the status of lecturers without having to go to their door.

The system was evaluated against its design goals, meeting the main criteria for providing easy-to-use, current, accessible information on the door; for providing a way of managing messages from the student to the lecturer via the Web and/or SMS; and for enabling the lecturer to manage and update the information displayed from a remote location.

References

Cheverst K, Fitton D, Dix A and Rouncefield M (2002). Exploring situated interaction with ubiquitous office door display. In *Proceedings of the International Workshop on 'Situated Interaction' at the ACM Conference on Computer Supported Cooperative Work, 16–20 November, New Orleans*.

Streitz NA, Röcker C, Prante Th, Stenzel R and van Alphen D (2003). Situated interaction with ambient information: facilitating awareness and communication in ubiquitous work environments. In *Proceedings of the Tenth International Conference on Human–Computer Interaction, 22–27 June, Crete*.

Multimedia m-learning using mobile phones

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Abstract

As mobile phones are getting smarter and more widely used, they have become a familiar tool in our environment. Using them as a learning tool calls for services that are compatible with the concept of communication tools. Here we propose a multimedia m-learning application that combines the advantages of text, image and sound using a combination of Wireless Markup Language (WML) pages and Multimedia Messaging Service (MMS).

Keywords
WML, MMS, collaboration

1 Introduction

Mobile phones are communication tools that may establish voice (sound), text and image links between people in order to exchange information and in this way can give support to the teaching and learning process. This implies getting information from a source; putting questions to and getting answers from a tutor; and exchanging ideas between students. All this must be in a simple form (Ring 2001); for example, a task definition or a motivational message, verifying the information gathered.

1.1 Scenarios

The scenario is a biology lesson in which a class of students (or pupils) have to recognise a plant following a WML text description and a multimedia message (MMS) provided by the tutor. The system provides a multimedia chat platform to encourage discussions and picture exchange with fellow students and with the tutor.

Accessing an encyclopaedia: the users can eventually send the plant picture to an artificial intelligence (AI) image recognition service that will detect the plant species. This service will be located on the server due to the low computational power of the mobile device.

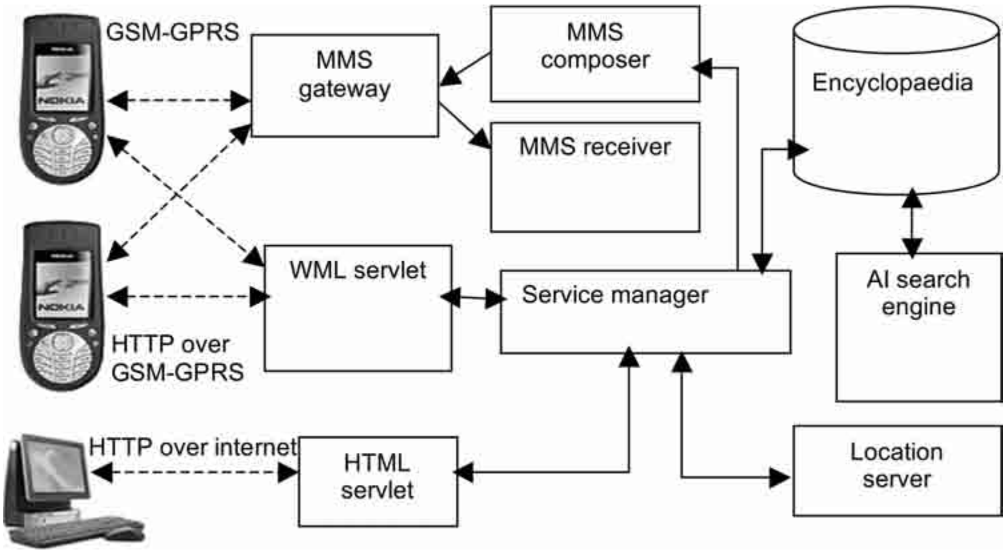
Location-adapted information: a location feature may also help students to do a mapping of how the plant spread in the area and to research the historical evolution of the plant's distribution in that region.

2 The architecture

The students are using Wireless Application Protocol (WAP) and Multimedia Messaging Service (MMS)-enabled phones to access the information (Stead 2003). The mobile phone's WAP browser reads the WML pages and displays the text within the link. If there is a need to listen to a sound or to see an image, the student may request an MMS with that content by clicking on a link. The teacher composes his or her lessons by adding text, links between pages, images and sounds related to a line of text, using a HyperText Markup Language (HTML)-based interface.

Figure 1 (overleaf) depicts the service architecture. The service responds with WML pages and MMSes, putting a response together on the spot. The content is retrieved from the encyclopaedia database and sustains the multimedia information exchange between the students and the tutor.

Figure 1 The service architecture



The architecture contains:

- the front-end components: MMS gateway (now SMS) that sends and receives MMS, the WML servlet that composes and responds with WML pages, and the HTML servlet – responsible for the tutor's interface
- the MMS composer which assembles an MMS message from given 'ingredients'
- the MMS receiver, which takes apart an MMS message and extracts the information (images, text, sound)
- the encyclopaedia database – which contains all the multimedia information necessary for the learning process
- the AI search engine, which is able to find in the encyclopaedia images or sounds similar to a given image or sound, using a classical pattern recognition algorithm
- the service manager which implements the service logic, the operation sequence, menus, etc
- the location server, an external and optional component which is useful to relate the service response to the location.

3 Results

The application has been tested on a group of 10 students. Their opinions about this application differ … Some are concerned about the content's relevancy, but most people think that it would be an interesting learning tool. The multimedia trend and the interactions with other people captured their attention very quickly. The students used the MMS to send non-didactical content too.

If it were implemented as a service, the costs would not be too high, assuming that packages of services at a special rate could be negotiated for MMS and given that costs per transfer for GPRS (General Packet Radio Service) are now lower than they used to be. In terms of its usefulness, the students thought that this example was good, but other implementations could be done. We intend to develop a location-based mobile-accessible encyclopaedia.

4 Conclusion

The paper presents a new m-learning multimedia service allowing interaction between the participants and access to information sources via WML and MMS. As the project develops, artificial intelligence (AI) and location features will be considered and an extension of the database content as well.

References

Freeman JA and Skapura DM (1991). *Neural networks: algorithms, applications, and programming techniques*. Addison Wesley Publishing Company.

Ring G (2001). Case study: combining Web and WAP to deliver e-learning. In *Learning Circuits*, June issue. Available via www.learningcircuits.org

Stead G (2003). Early footsteps and next steps: 'm-learning' with disengaged young people. Paper presented at the MLEARN Conference 2003, London, 19–20 May.

Finding the appropriate learning objects: human, mobility and community issues

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Abstract

This paper describes an approach to the description of the educational characteristics of learning objects which aims to reflect the demands of mobile use; it also addresses human factors related to the creation of the relevant metadata.

Keywords
metadata, ontology, human–computer interaction (HCI)

1 Introduction

In the education domain there are several specifications (eg McKell and Thropp 2001) and standards (IEEE 2002) for metadata descriptions of learning objects. These are intended to enable computer systems to identify instances relevant to a user's needs. These specifications and standards break the description down into several categories such as 'general', 'technical' and 'educational'. Unlike many of the other categories of descriptors, most of those in the educational category cannot be determined by analysing the learning object itself, because these descriptors describe characteristics of the expected use of the object, rather than of the object itself (Marshall 1998). Examples include descriptors of the *difficulty* of a learning object, and of the *typical age range* of the intended users. Mobility of learners can imply further degrees of uncertainty about the expected use of the learning object, and this paper discusses an approach to the creation of the educational category of descriptors which takes account of the need for human production of most of the descriptors in this category.

2 Research issues

Consider an organisation which produces a variety of learning objects with a specific target audience (ie specific groups of learners) in mind. This organisation could be a university or a commercial publisher, but for the sake of this example, assume that it is a university producing learning objects for its students. Each learning object includes IEEE LOM (Institute of Electrical and Electronics Engineers Learning Object Metadata) standard metadata, including metadata in the educational category.

Chan *et al.* (2004) considered the suitability of the IEEE LOM for the mobile learning scenarios produced by the MOBIlearn project, and concluded that the only changes necessary were in respect of rights management. Accepting that the educational category is suitable for use in mobile learning scenarios, consider one element from that category – the 'difficulty' element – as an example.

With respect to the 'difficulty' element, the explanatory note in the IEEE standard states (IEEE 2002): 'How hard it is to work with or through this learning object for the typical intended target audience.' It should be noted that with respect to both the 'typical learning time' and 'difficulty' elements, the standard states: 'NOTE – The "typical target audience" can be characterized by data elements 5.6:Educational.Context and 5.7:Educational.TypicalAgeRange'.

Now consider that the university in question has made collections of its objects available to third parties – for example, via an initiative similar to MIT OpenCourseWare (MIT 2003); or via commercial relationships with individual organisations – for example, institutions such as museums or art galleries.

In the former case (OpenCourseWare-type initiative), the objects will be freely available on the internet to any learner; and in the latter case (museum or art gallery), the institution in question wishes to enable visitors to the institution to learn from appropriate learning objects and thus makes the objects available via a wireless system within its building. Note that in this paper, only issues concerned with the metadata description of the objects is of interest, so the issues of transforming and rendering objects on a variety of mobile devices – personal digital assistants (PDAs), mobile phones, etc – are not discussed.

Next we consider the situation described by Lonsdale *et al*. (2004), one in which a context awareness system filters and selects objects appropriate to a learner's context from a database of available objects. The selection and filtering operations described by Lonsdale *et al*. require that the metadata descriptors of the educational characteristics of the learning objects can be correctly interpreted by the context awareness system. If learning objects contain educational metadata which is appropriate to only one educational context (which is characterised by the Educational.Context and Educational.TypicalAgeRange elements in the IEEE LOM), then that is not sufficient for the context awareness system to select and filter objects from a variety of contexts.

For instance, a specific learning object from an undergraduate art history course is described as of 'medium' difficulty for art history undergraduates studying the course that the object is part of. In other words, the community of practice which produced the learning object (ie lecturers at the university) have decided that this learning object is of 'medium' difficulty for the community it is intended for – art history undergraduates at the university. If it is to be correctly filtered and/or selected on the basis of its difficulty for other contexts, then 'difficulty' and 'typical target audience' metadata must be created for those contexts; or a mechanism which allows the interpretation of relationships between contexts must be introduced. As stated earlier, 'difficulty' and 'typical target audience' metadata is metadata which describes the expected use of an object, and thus cannot be automatically generated – it must be generated by people. Experience at the Open University and elsewhere (eg Chan 1989) has shown that human-produced metadata is often neither complete nor consistent: thus it was decided to focus on other approaches to achieve the desired result.

3 The approach

The approach that has been developed and realised as a working prototype in OWL (Web Ontology Language) (McGuinness and van Harmelen 2003) is an ontology which can act as a mechanism for relating perceptions of difficulty appropriate to an individual educational context to perceptions of difficulty in another educational context. For example, one educational context could be characterised as *undergraduates studying for an art history degree*; and the other could be characterised as *people with a higher level of education, but not in art history, who are visiting an art gallery*.

The ontology enables the establishment of a relationship between descriptions of difficulty appropriate to one context and an expectation of perceptions of difficulty in the other context. For instance, for two contexts (**context1 and context2**), a set of useful descriptors for this relationship is as follows.

- Assignments of difficulty made in this context (**context1**) are perceived as 'more difficult' than assignments of difficulty made in this context (**context2**).
- Assignments of difficulty made in this context (**context1**) are perceived as 'less difficult' than assignments of difficulty made in this context (**context2**).
- Assignments of difficulty made in this context (**context1**) are perceived to be 'as difficult' as assignments of difficulty made in this context (**context2**).

It should be noted that in this case, 'assignment' should be interpreted as 'the action of assigning', not as 'a task allocated to somebody as part of a course of study'.

4 Conclusions

This ontology enables metadata descriptions of 'difficulty' appropriate for one context to be correctly interpreted for learning that is occurring in other contexts, provided that the relationship between the two contexts has been instantiated. This instantiation does require human intervention, but as it describes relationships between contexts, only one instance is required for each pair of contexts (compared with additional metadata for every learning object in the alternative approach discussed above).

Furthermore, the 'difficulty' metadata that is appropriate to one context (eg an undergraduate art history degree) can be created by experts from the relevant community of practice (ie the lecturers on the course), for whom there is the motivation to ensure the creation of accurate and consistent metadata. Moreover, the instantiation of the context relationship can be achieved via a discussion between people who have endemic motivation to ensure that the relationship is correctly captured; for example, senior managers or lecturers at the relevant organisations.

References

Campbell LM (2003). Engaging with the learning object economy. In A Littlejohn (ed.) *Reusing online resources: a sustainable approach to e-learning*. London: Kogan Page Ltd, 35–45.

Chan LM (1989). Inter-indexer consistency in subject cataloguing. *Information Technology and Libraries*, 8, 349–358.

Chan T, Sharples M, Vavoula G and Lonsdale P (2004). Educational metadata for mobile learning. In J Roschelle, T Chan, Y Kinshuk and SJH Yand (eds) *Proceedings of the 2nd IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE)*. Computer Society Press. At http://csdl2.computer.org/comp/proceedings/wmte/2004/1989/00/19890197.pdf

IEEE (2002). IEEE Standard for Learning Object Metadata. IEEE Std 1484.12.1–2002. New York: The Institute of Electrical and Electronics Engineers.

IMS (2001). *IMS learning information package specification*. At www.imsglobal.org/profiles/, accessed 12 May 2004.

Lonsdale P, Barber C, Sharples M and Arvantis TN (2004). A context-awareness architecture for facilitating mobile learning. In J Attewell and C Savill-Smith (eds) *Learning with mobile devices*. London: Learning and Skills Development Agency, 167–171.

Marshall C (1998). Making metadata: a study of metadata creation for a mixed physical–digital collection. In *Proceedings of the ACM Digital Libraries '98 Conference*. New York: ACM Press, 162–171.

McGuinness DL and van Hamelen F (2003). *OWL Web Ontology Language overview*. At www.w3.org/TR/owl-features/, accessed 21 May 2004.

McKell M and Thropp S (eds) (2001). *IMS Learning Resource Meta-data Information Model. Version 1.2.1: final specification*. Burlington, MA: IMS Global Learning Consortium. At www.imsglobal.org/metadata/imsmdv1p2p1/imsmd_infov1p2p1.html, accessed 5 September 2005.

MIT (2003). *MIT OpenCourseWare*. At http://ocw.mit.edu/, accessed 10 June 2004.

Development of a research plan for use of ambient technology to test mobile learning theories

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Abstract

This paper reports on the progress that has made been towards the development of a research plan to enable ambient technology to be employed as a tool which researchers can use when testing theories of learning with mobile devices, and developers can use when evaluating mobile learning systems. It describes the approach used, informed by the T-Plan approach developed by Phaal, Farrukh and Probert (2004), and the progress made by examining sources including:

- existing academic research which tests theories of learning (eg Moreno 2004)
- for evaluating educational software (eg Jones *et al*. 1999)
- information about relevant existing and emerging technologies such as those for identification of physical objects (eg RFID); data communication (eg GSM, GPRS, WLAN, UMTS or Bluetooth); outdoor location (eg GPS or GNSS); indoor location (eg infrared or optical); and video and audio data capture.

Keywords
ambient technology, evaluation, theory of learning

1 Introduction

This paper focuses on the potential of ambient technology to obtain quantitative data about learners' interactions with all kinds of learning materials in such a way that the learners are unaware of the process of the data capture. It describes some preliminary work towards the development of a research plan which, if followed, aims to enable ambient technology to be employed as a tool which researchers can use when testing theories of learning with mobile devices, and which developers can use when evaluating mobile learning systems.

The need for this research (and hence its inclusion in the development of the MOBIlearn road map) was initially prompted by papers describing methodological difficulties with media comparison studies (eg Joy and Garcia 2000).

It describes the method used, informed by the T-Plan approach developed by Phaal, Farrukh and Probert (2004), and the progress made by examining sources including:

- existing academic research which tests theories of learning (eg Moreno 2004)
- frameworks for evaluating educational software (eg Jones *et al*. 1999)
- information about relevant existing and emerging technologies such as those for identification of physical objects [eg RFID (Radio Frequency Identification)]; data communication [eg GSM (Global System for Mobile Communications) GPRS (General Packet Radio Service), WLAN (Wireless Local Area Network), UMTS (Universal Mobile Telecommunications System) or Bluetooth]; outdoor location [eg GPS (Global Positioning Systems) or GNSS (Global Navigation Satellite Systems)]; indoor location (eg infrared, optical); and video and audio data capture.

We conclude by summarising some issues which are critical to the success of such a research plan.

2 Framework: the T-Plan approach

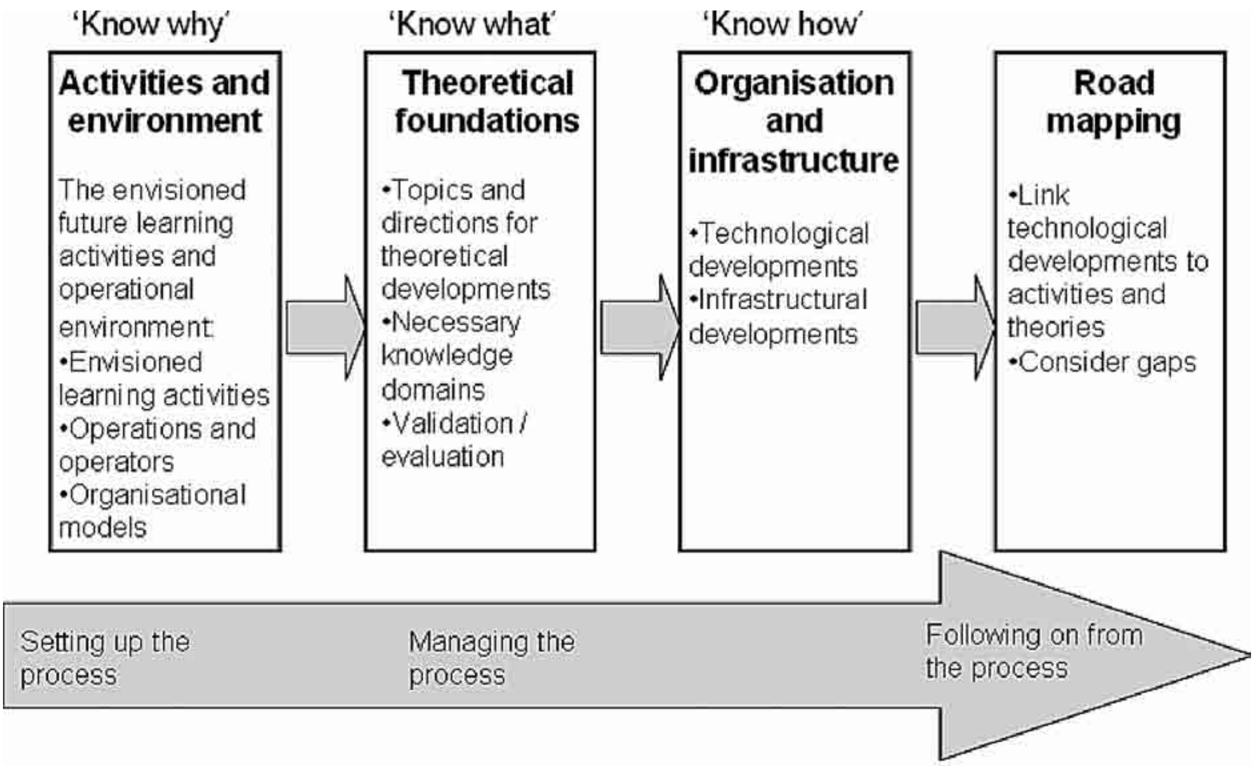
The aim of a science and technology research 'road map' is to provide a consensus view or vision of the future landscape available to decision makers. The road-mapping process provides a way to identify, evaluate and select strategic alternatives that can be used to achieve a desired science and technology objective (Kostoff and Schaller 2001).

This paper describes one aspect of work towards the development of a 'road map for further research into the theory and practice of learning in a mobile environment supported by new technologies' being carried out within the MOBIlearn project (MOBIlearn 2002). The process adopted by MOBIlearn is based on the T-plan approach (Phaal, Farrukh and Probert 2004), which has been designed to generate road maps for product planning and development. Key reasons for considering the T-Plan approach within the short timescale permitted in the collaborative MOBIlearn project are as follows.

- It has been developed to support the rapid initiation of road mapping.
- It provides a customised approach which includes guidance on the broader application of the method beyond its primary purpose of supporting product planning.
- It was developed during a 3-year programme in which more than 20 road maps were developed, and it has been applied more than 40 times.
- The general principles of the approach have been used to develop multi-organisation (or collaborative) road maps (Phaal, Farrukh and Probert 2004).

The T-Plan approach entails four facilitated workshops, the first three of which focus on the three main layers of the road map, with the final workshop bringing the themes together on a timescale-basis to construct the road map. A schema of the process as adapted for the MOBIlearn project is shown in **Figure 1**. Phaal, Farrukh and Probert (2004) make the point that 'Often a considerable part of the initial roadmapping effort will be directed at defining the layers and sublayers that will form the roadmap'; and this paper is one output of that initial effort. The work described in this paper is intended to expose aspects of our current thinking about two layers: the 'theoretical foundations' layer and the 'organisation and infrastructure' layer. With reference to the theoretical foundations layer, we propose that the road map should include developments to existing models for evaluation and validation; and with reference to the organisation and infrastructure layer, we propose the necessary technological developments as part of an 'ambient technology' sub-layer.

Figure 1 Adaptation of the T-Plan process steps for the MOBIlearn project
Adapted from Phaal, Farrukh and Probert (2004)



With respect to the sources identified in section 1, the first two – existing academic research which examines theories of learning; and frameworks for evaluating educational software – reflect the current state of the art with respect to testing theories of learning, and hence feed into the development of the 'theoretical foundations' layer. The third source – information about relevant existing and emerging technologies – reflects the state of the art and potential future evolution of ambient technology, and thus is crucial for the 'organisation and infrastructure' layer. An analysis of these sources has yielded topics and issues which we believe need to be discussed at the relevant workshops for these two layers. This analysis is discussed in more detail in section 3 and section 4 respectively.

3 Theoretical foundations: evaluation and validation

Our first step is to define what we mean by 'mobile learning', and what this implies in terms of techniques for evaluation and validation. Rather than adopting a definition of 'mobile learning' which takes account only of uses of certain technologies, the MOBIlearn project has adopted a broader definition: 'Any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies.' (O'Malley *et al*. 2003).

In terms of evaluation and validation, Taylor (2004) promotes analysis of activities and design of mobile systems to support the learning activities, stating that:

From the evaluator's point of view, then, the task is to evaluate the effectiveness with which learners are able to achieve their goals, and complete learning activities, irrespective of the specific devices that might have been used in doing so. Indeed, the same or similar activities could be instantiated in a variety of different ways depending on availability of technical support (eg access to wireless Local Area Network, LAN) and user preferences. In so doing, we will necessarily be evaluating the validity of the tasks themselves as vehicles for learning.

Therefore, it is the system plus the environment that must be evaluated, using a task-centred approach. The work described here is thus a first step towards investigating the potential of ambient technology to obtain quantitative data about learners' interaction with materials in such a way that the context of the learner's tasks is naturalistic, and the learners themselves are unaware of the processes of data capture.

Referring back to the definition of mobile learning stated above, we initially focus our attention on learning opportunities offered by mobile technologies, and thus consider an existing framework for evaluation of educational software. **Figure 2** shows a version of the CIAO (context, interactions, attitudes and outcomes) framework (Jones *et al*. 1999) which has been amended to identify modifications that make it appropriate for our purposes – that is, to exploit ambient technology. Components to which ambient technology could hypothetically contribute are shown in bold text in the cells.

Figure 2 The CIAO framework (context, interactions, attitudes and outcomes)

	Context	**Interactions**	**Attitudes and outcomes**
Rationale	The aims and the context of use	Data about students' interactions with the software allows some analysis of the process	It is important to try to assess learning outcomes, but also to consider effective outcomes; eg a change in perceptions and attitudes
Data	Designers' and course team's aims. Policy documents and meeting records	**Records of student interactions**; **products of students' work**; student diaries; **online logs**	**Measures of learning**; changes in students' attitudes and perceptions
Methods	Interview CAL (computer-assisted learning) designers and course team members; analyse policy documents	**Observation**; diaries; **video/audio and computer recording**	Interviews; questionnaires; tests

The CIAO framework encompasses both qualitative and quantitative techniques. This paper is focusing on quantitative techniques and thus we must consider the ability of quantitative techniques to generate reliable and valid data with respect to learning. Many researchers have reported difficulties with quantitative techniques, including validity of interpretation of observations (because similar observed behaviours can represent very varied mental processes and intentions) and problems with moving from statistical to causal relationships between observed events (see eg Wegerif and Mercer 1997). We recognise that similar difficulties will occur if the observations are a result of ambient technology rather than of a human observer.

3.1 Previous studies

As a starting point we take our first source: studying existing peer-reviewed academic research which has devised and utilised methods to gather and record quantitative observational data. First, we hypothesise as to how ambient technology could improve the recording of observational data. We then hypothesise how the theoretical extensions to the CIAO evaluation framework discussed above could be realised using ambient technology. In section 4, we consider the capabilities of the ambient technology that exists today, and we hypothesise developments and improvements to this technology that would enable the theoretical extensions to the CIAO framework to be realised.

So far, our analysis of published studies of mobile learning indicates that with respect to evaluation and validation of mobile learning, ambient technology can be used to:

- identify gaps between what people say they do and what they actually do (Smørdal and Gregory 2003); for example, to validate information gained via questionnaires and interviews
- generate additional information about learner behaviour during longitudinal studies of temporally and spatially distributed learners (eg to contribute to a study such as is currently underway within the MOBIlearn project (MOBIlearn 2002)
- record data about social processes that occur during learning episodes that may not otherwise be accessible to researchers (eg the collaborative learning episodes reported in Lundin and Magnusson 2003; and in Zurita and Nussbaum 2004).

A consideration of technological and infrastructural issues related to these propositions is presented in section 4.

4 Organisation and infrastructure: ambient technologies

Section 3.1 described potential applications of ambient technology for evaluating and validating theories of learning. With respect to these potential applications, we can postulate that at the very least, we need to consider in a workshop the generation of positional data (related to both people and objects); temporal data (related to both people and objects); and audio and/or video data (related to social interactions).

We now focus our analysis on technological and infrastructural issues which need to be researched and developed as part of the road map.

Hill *et al*. (2004) describe a range of platform classes of nodes (hardware and software combinations) which can be used to create wireless sensor networks. The classification consists of four classes of nodes (special-purpose sensors; generic sensors; high-bandwidth sensors; gateway), where gateway nodes interface to existing networks (eg the internet); high-bandwidth nodes capture, for example, audio and video data; generic nodes detect, for example, motion; and special-purpose nodes are low-power cubic-millimetre scale devices which are designed and programmed to perform specific functions. The authors state: 'While the capabilities, cost, and size of each class of device will change with technological advances, these four fundamental classes of device will likely remain for the foreseeable future.'

Thus this classification appears to be a useful starting point for discussions, at workshops and other forums, of these kinds of powered sensor. In addition, no matter what the nature of the sensor, there will be wireless security and interference issues which will have to be considered, in addition to a variety of potential mechanisms for locating people and objects in time and space.

Specific examples of the utilisation of such devices include the technique of Back *et al*. (2001) for monitoring page movements using RFIDs – that is, a method to gather data related to people's interaction with books. This was used successfully in the Listen Reader project (Back and Cohen 2000), which also used sensors to detect the motion of a reader's hands.

5 Conclusions

This paper has considered a variety of issues which affect the creation of a research road map to explore the potential of ambient technology for use as a tool to enable researchers to validate theories of learning. It has identified ways in which ambient technology could be used with respect to mobile learning; and has put forward frameworks for discussion of relevant issues which should enable fruitful road-map workshops to occur.

As stated in section 3, there are problems concerning the interpretation of observational data, and in moving from statistical to causal relationships between observed events, that will affect the usefulness of any data that is generated by ambient technology. These are perhaps the most difficult and challenging issues that the research plan discussed here will have to face.

We have not considered how to integrate quantitative data with qualitative data in this paper, and we recognise that consideration of such integration should be included in the discussion that will occur during the development of the road map.

Finally, with respect to technological developments, it is apparent that the rate of advance of technologies which can be used in or as ambient devices is continuing and will continue over the next decade. This being so, social and legal issues such as security and privacy will have an impact on the utilisation of such technology, and thus must also be considered and discussed.

References

Back M, Cohen J, Gold R, Harrison S and Minneman S (2001). Listen reader: an electronically augmented paper-based book. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. New York: ACM Press, 23–29.

Back MJ and Cohen J (2000). Page detection using embedded tags. In *Proceedings of the 13th Annual ACM Symposium on User Interface Software and Technology*. New York: ACM Press, 159–160.

Hill J, Horton M, Kling R and Krishnamurthy L (2004). The platforms enabling wireless sensor networks. *Communications of the ACM*, 47, 41–46.

Jones A, Scanlon E, Tosunoglu C, Morris E, Ross S, Butcher P and Greenberg J (1999). Contexts for evaluating educational software. *Interacting with Computers*, 11, 499–516.

Joy EH and Garcia FE (2000). Measuring learning effectiveness: a new look at no-significant-difference findings. *Journal of Asynchronous Learning Networks*, 4, 33–39.

Kostoff RN and Schaller RR (2001). Science and technology roadmaps. *IEEE Transactions on Engineering Management*, 48, 132–143.

Lundin J and Magnusson M (2003). Collaborative learning in mobile work. *Journal of Computer Assisted Learning*, 19, 273–283.

MOBIlearn (2002). *Next-generation paradigms and interfaces for technology supported learning in a mobile environment. Exploring the potential of ambient intelligence*. Project No IST–2001–37187. Technical Annex. MOBIlearn Consortium.

Moreno R (2004). Decreasing cognitive load for novice students: effects of explanatory versus corrective feedback in discovery-based multimedia. *Instructional Science*, 32, 99–113.

O'Malley C, Vavoula G, Glew JP, Taylor J, Sharples M and Lefrere P (2003). *Guidelines for learning/teaching/tutoring in a mobile environment*. MOBIlearn deliverable D4.1. At www.mobilearn.org/download/results/guidelines.pdf, accessed 15 June 2004.

Phaal R, Farrukh CJP and Probert DR (2004). Technology roadmapping – a planning framework for evolution and revolution. *Technological Forecasting and Social Change*, 71, 5–26.

Smørdal O and Gregory J (2003). Personal digital assistants in medical education and practice. *Journal of Computer Assisted Learning*, 19, 320–329.

Taylor J (2004). A task-centered approach to evaluating a mobile learning environment for pedagogical soundness. In J Attewell and C Savill-Smith (eds) *Learning with mobile devices*. London: Learning and Skills Development Agency, 167–171.

Wegerif R and Mercer N (1997). Using computer-based text analysis to integrate qualitative and quantitative methods in research on collaborative learning. *Language and Education*, 11, 271–286.

Zurita G and Nussbaum M (2004). Computer supported collaborative learning using wirelessly connected handheld computers. *Computers and Education*, 42, 289–314.

Interactive Logbook: the development of an application to enhance and facilitate collaborative working within groups in higher education

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Abstract

This paper describes the development of Interactive Logbook, an application designed primarily for university students, to facilitate and enhance individual and collaborative learning in higher education. Interactive Logbook exploits the Tablet PC architecture to incorporate wireless communication, natural handwriting input and context awareness, and provides a seamless integration of tools for learning, collaboration, and time management. The development follows closely the socio-cognitive engineering methodology (Sharples *et al*. 2002) for the human-centred design of educational learning technology. In addition, usability evaluation techniques such as card sorting, heuristic evaluations and field studies have been used to ensure that the system interface is intuitive, uncluttered and easy to use.

Keywords
Tablet PC, collaborative, computer-supported collaborative work, higher education, context awareness, groupware

1 Introduction

A recent development within education, particularly higher education, is support for group and collaborative learning. Previous research has shown that peer collaboration is an effective means of learning (Collier 1980; Johnson, Johnson and Smith 1991). Although the results of this research have been available for over 20 years, it has only recently had a widespread influence within higher education. It is now accepted that a significant part of a degree should include working within small groups towards the successful completion of a project. To benefit from group work, the students need to communicate and share ideas quickly and efficiently. New communications technology can offer tools for distributed team working, but these have mostly been designed for work in business teams rather than student learning.

The aim of Interactive Logbook is to provide an integrated suite of tools to facilitate and enhance collaborative learning by small groups within a higher education (HE) setting. In conjunction with this aim, the emergence of Tablet PCs as a viable alternative to desktops, laptops and personal digital assistants (PDAs) was recognised, and the increased mobility and accessibility of this form of tool was harnessed to improve distributed group working.

A collaborative tool is not a new idea, nor is the ability to work wirelessly while mobile. Wireless and mobile technology for use within education has been available for some 10 years or more (Wayne 1993), but the barriers to implementation, such as cost and technology limitations, have only recently been overcome.

A similar system is the CoVis Collaboratory Notebook (Edelson and O'Neill 1994), which provided a knowledge base to enable remote collaboration between students, academic staff and professionals. However, this is now very similar to an internet message board and is therefore somewhat limited and outdated. There has also been developments in software tools that aid students to organise their studies more effectively. These are not necessarily collaborative applications, but they indirectly increase peer collaboration through greater personal organisation and local access to resources. A recent example of such an application is the Student Learning Organiser (SLO) (Holme and Sharples 2002). This was designed for the Pocket PC and provided a mobile platform for students to organise their studies, including tools for management of time and resources. The authors took several key points from this project, including the necessity for such organisational tools and the need for a mobile device to provide anywhere, anytime access to required information.

2 Development procedure

To complete the complex task of building such an application, a socio-cognitive engineering methodology (Sharples *et al*. 2002; see **Figure 1**) was adopted. This allowed an analytic approach to the design of human-centred technology. Through consideration and combination of several different viewpoints, it facilitated the development of the system, but ensured that the main focus throughout the development was on the user.

Socio-cognitive engineering breaks system design into building blocks, each of which is necessary to deliver a successful application, as outlined in **Figure 1**. The left-hand side, including *general requirements*, *field studies* and *theory of use*, provides a user-orientated approach to the analysis of activity and theory, related to collaborative learning in small groups. The *task model* integrates these into a coherent depiction of how students learn together with their current technologies. The *task model* also indicates limitations of current learning and teamwork practices that can inform the design of new technology. It enables an iterative process of system design and evaluation, which is represented by the right-hand side.

3 Aims and general requirements

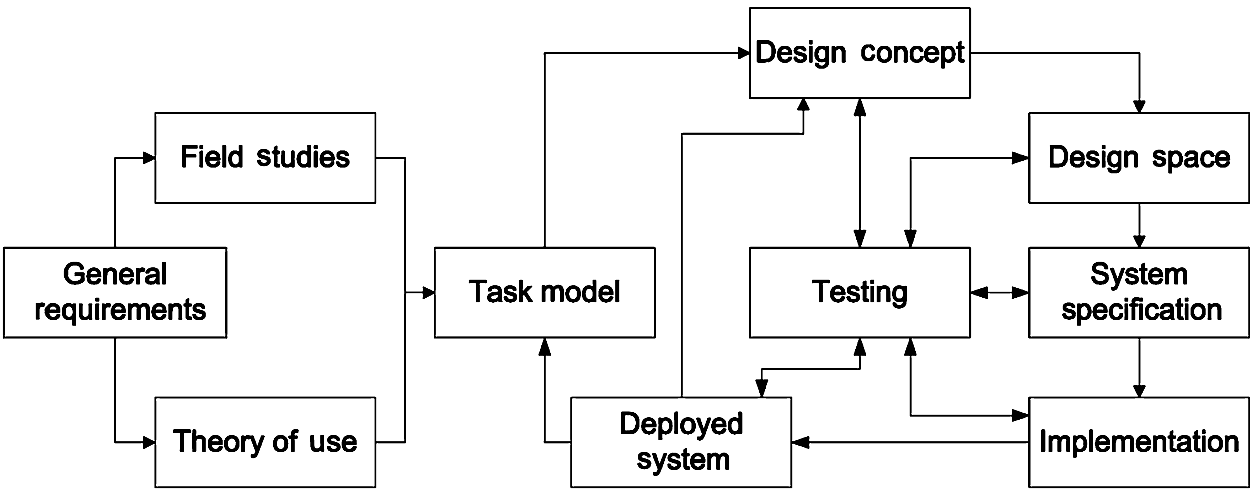
Interactive Logbook is intended to assist students in coordination and collaborative problem solving, through previously gained knowledge, but not to support basic learning or knowledge gathering.

The initial general requirements were identified by undertaking brainstorming sessions with potential users from different academic backgrounds. The requirements include the ability to communicate effectively, to share resources and information and to create collaborative documents. In addition, the brainstorming sessions showed the necessity for personal and group organisational tools, and the possibility of contextually aware devices was highlighted.

The *theory of use* (see **Figure 1**) was constructed through research into cognitive processes and the social interactions involved when students collaborate to reach a common goal. The findings of this research showed that the advantages of collaborative learning over independent study lie in the processes of articulation, conflict and co-construction of ideas between collaborating peers (Crook 1996). Dillenbourg *et al*. (1996) suggest that when considering such processes, it is necessary to differentiate between learning and problem solving; and also between collaboration and cooperation.

Consideration of the differences between collaboration and cooperation suggests that Interactive Logbook should be designed to ensure a high level of mutual contributions to attaining a common goal. This is in contrast to simply dividing work between group members.

Figure 1 Socio-cognitive engineering methodology
Source: Sharples *et al*. 2002



Facilities should be provided to ensure that coordination is simple and effective between group members, and that contributing to a task while interacting with group members is feasible and simple.

In combination with the *theory of use*, the *field studies* attempted to discover the requirements of potential users. The *field studies* took the form of questionnaires, scenarios and focus groups, which pointed to a core set of requirements to be included in the final application. These requirements included natural handwriting input, peer messaging and time-management facilities.

4 Ensuring usability

Usability issues were highlighted during design and developments through the use of *field studies* undertaken with several groups of potential users and experienced usability experts.

Possible interface designs were drafted and shown to groups of students so that they could select and modify the designs. In addition, 15 students from a cross-section of courses took part in a card sort. Students grouped related functions, such as Calendar, To Do's and Appointments into a common group which was named appropriately, Diary.

This consultation process ensured ease of use, as the target users were consulted throughout the design process.

The result was the identification of four groups: Programs; Modules; Meetings; and Diary.

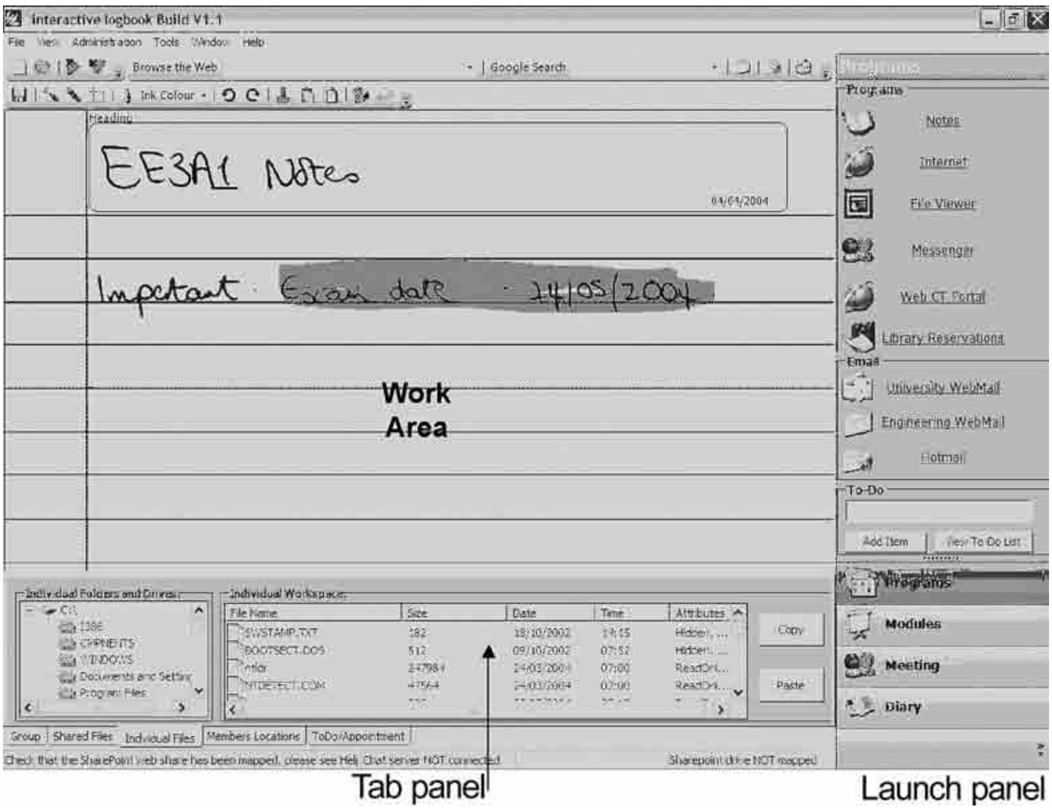
5 Development tools and functionality

Interactive Logbook v1.1 is the first usable release compiled by the authors. The application employs the .NET architecture and utilises the Tablet PC SDK. Several user interface (UI) components were provided by Divil (2004). **Figure 2** gives a typical overview of the Interactive Logbook's interface.

The main source of user interaction is the Launch Panel to the right-hand side of the interface, from which four separate sections can be accessed.

- *Programs*: provides easy access to 'mini applications' from within Interactive Logbook, such as the internet, text messaging to peers, and freehand notes entry.
- *Modules*: provides access to teaching material at the user's request by selecting the name of a course module. It also displays relevant lecture material if the calendar shows a lecture in progress at the current date and time.

Figure 2 The Interactive Logbook user interface



- *Meeting*: provides collaborative tools such as access to previous group minutes and initiation of a peer-to-peer whiteboard session.
- *Diary*: provides time-management features. These include To Do's and Appointments, represented in a Calendar view.

Furthermore, a Tab Panel located towards the bottom of the interface provides the student with access to shared group resources and private resources. It also allows simple file manipulation.

Location sensing of other group members is provided by the Ekahau (2004) positioning engine. Some functionality is provided for users who belong to a number of project groups. The current group environment may be swapped to permit the access of resources related to another group to which the current user belongs.

Finally, administration, though still in its infancy, is present in this release of Interactive Logbook. It allows the use of Interactive Logbook on any shared network space and the use of the system by lecturers, who may add teaching material to a particular lecture slot in the calendar, thereby allowing that material to be displayed when the date and time for that lecture arises. Lastly, administrators may create year timetables that can be offered to all students, providing reminders and related teaching material from the Interactive Logbook system.

6 Further developments

Interactive Logbook is still a prototype system. The authors are committed to using feedback gained from the initial release to improve the usefulness of the system.

The collaborative features will be developed to improve its usefulness in group-working scenarios, team whiteboard sessions, ink messaging and administration of teams by the Interactive Logbook server. In addition, the authors will ensure that existing features are as comprehensive as possible – for example, the adaptability of the software depending on the environment of the student; the addition of multimedia elements to notes and administrative tools. Finally, the reliability of Interactive Logbook will be evaluated and improvements made to ensure more sophisticated data handling in shared environments.

The authors intend to continue development with the aim of establishing Interactive Logbook as an indispensable tool for students using Tablet PCs.

References

Collier KG (1980). Peer-group learning in higher education: the development of higher-order skills. *Studies in Higher Education*, 5(1), 55–62.

Crook C (1996). *Computers and the collaborative experience of learning*. New York: Routledge.

Dillenbourg P, Baker M, Blaye A and O'Malley C (1996). The evolution of research on collaborative learning. In H Spada and P Reimann (eds) *Learning in humans and machines*. Oxford: Pergamon Press, 189–211.

Divil (2004). *Website*. At www.divil.co.uk/net/, accessed January 2004.

Edelson DC and O'Neill DK (1994). The CoVis Collaboratory Notebook: supporting collaborative scientific enquiry. In A Best (ed.) *Proceedings of the 1994 National Educational Computing Conference*, 146–152.

Ekahau (Jan 2004). *Website*. At www.ekahau.com, accessed January 2004.

Holme O and Sharples M (2002). Implementing a student learning organiser on the Pocket PC platform. In *Proceedings of the European Workshop on Mobile and Contextual Learning, Birmingham*, 41–44.

Johnson DW, Johnson RT and Smith KA (1991). *Cooperative learning: increasing college faculty instructional productivity*. ASHE–ERIC Higher Education Report No 4. Washington DC: The George Washington University, School of Education and Human Development. (ERIC Document Reproduction Service No ED 343465)

Sharples M, Jeffrey N, du Boulay JBH, Teather D, Teather B and du Boulay GH (2002). Socio-cognitive engineering: a methodology for the design of human centred technology. In *European Journal of Operational Research*, 136(2), 310–323.

Smith R, O'Shea T, O'Malley C, Scanlon E and Taylor J (1991). Preliminary experiments with a distributed multimedia problem solving environment. In J Bowers and S Benford (eds) *Studies in computer supported cooperative work: theory, practice and design*. Amsterdam: Elsevier, 31–48.

Wayne C (1993). Wireless coyote: a computer-supported field trip. *Communications of the ACM*, 36(5), 57–59.

Determining location in context-aware mobile learning

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Abstract

Context-aware mobile learning systems rely on the availability of information about a mobile user. One of the most obvious aspects of context is location (Small, Smailagic and Siewiorek 2000), and several methods exist to determine a user's position, varying not just in the accuracy of the information they provide, but also in the extent to which they intrude on the user's experience. Issues with intrusiveness also arise when this information is used. For instance, a user may not necessarily want content in their browser automatically updated whenever they change position, or when they are busy with other activities.

This paper describes the ongoing development of a testbed to explore some of these methods and issues by modelling a mobile learning scenario involving a visit to an art gallery. A user with a mobile device will have the most relevant content made available as he or she moves around the gallery.

Keywords
context, location, mobile learning, wireless

1 Approaches to determining location

An important aspect of many context-aware mobile systems is the need to know where a user is, or what they are doing at a given time. In addition, we may be interested in a history of their movements; for example, if a user in a gallery is studying a series of paintings by one artist, we may be interested in which ones they have already visited, and perhaps in which order.

Given reliable and accurate location information, we are also interested in how to use it in the best and most unobtrusive way. Users may not want to have to constantly request new content as they move around the gallery, but they may quickly become irritated if content is automatically updated whenever the system decides they have moved enough to change their current context (Jones and Brown 2002). They may also be engaged in some other activity, which limits the amount of information they can accept, something that may also be taken into account by a context-aware system (Lonsdale *et al*. 2003).

1.1 Architecture

The location-sensing component of a context-aware system should ideally be independent of other components, and its output should be in a general, portable form that can be consumed by a range of applications or other components in the same system (Bauer, Becker and Rothermel 2001). A location service may also manage information from more than one type of positioning system; for example, an ultrasound positioning system could be used in conjunction with Radio Frequency Identification (RFID) tags. Our testbed will use a web services architecture in which the location service periodically updates the context-aware system with the positions of all the users it is tracking. Location information is passed as Extensible Markup Language (XML), described by a simple schema, allowing location 'objects' to be exchanged between components or services.

1.2 Types of position information

The location information provided by a location service can be broadly divided into two main types: *absolute* and *proximity*.

With an absolute location, we have a position for the user within the area or space covered by the location service. This could take the form of XY coordinates, or perhaps a floor of a building or a logical area. This kind of position information is more flexible than proximity position information and can be more independent of other parts of a context-aware system.

A proximity position only tells the system which item of interest a user is closest to, and includes no information about their position in a wider sense. The position information could simply be, for example, the name of the picture or exhibit in a gallery that the user is interested in; however, this information is not very portable and could only be understood by specific applications or components of a context-aware system.

1.3 Types of location service

There are also two main approaches to determining position, which can be described as *continuous* and *intermittent*.

In a continuous location service, a user's position is known at all times as they move through the space covered by the location service. The service is transparent to the user – that is, they do not need to be concerned with how it is done or provide any input into the system. A good example of this type of tracking is the Ekahau (2005) positioning engine, which uses the signal strengths received by mobile devices on a wireless local area network (WLAN) to calculate their position. The advantage of this kind of system is that it is unobtrusive and provides more information to a context-aware system, enabling it to offer a wider range of services. A continuous service would probably return absolute position information, varying in accuracy according to the system being used.

In an intermittent service, the user must actively provide the system with information about their position; for example, by passing an RFID reader over a tag, or perhaps lining up their device with an infrared (IR) beacon. This type of system is more suited to an 'object-based' scenario like a gallery or museum, in which individual objects can be identified or tagged. The system has no knowledge of a user's location until they (or their device) interact with a tagged object and in effect, are explicitly requesting information about that item. In this case, the location service is more obtrusive. This type of service might typically provide proximity location information, although it could also provide an absolute position.

The testbed will include location sensing of both types.

2 Using location information effectively

In general, a continuous service can provide more information to a context-aware system, enabling it to offer a wider range of services or build a more complete history of the user's movements. For example, a user in our art gallery scenario might use their device to read an RFID tag, notifying an intermittent service that they are in front of a painting by Botticelli, and the context-aware system could then provide appropriate content for that picture. But with information from a continuous location service, the system could also point out works by other artists that may be of interest when the user passes them as he or she moves through the gallery.

However, the more obtrusive intermittent approach to finding location does have a significant advantage: we know a user is interested in an object or service. A continuous, unobtrusive service can tell us that a user is near an object, but this does not necessarily mean that they are interested in it or in any associated services or content.

3 Aims of the research

Several methods and systems for location sensing will be explored and assessed through user trials, with regard to three main criteria:

- the ability to deliver accurate and reliable location information to the context awareness system
- the impact on the user's experience as they move through the gallery
- the need for the user's device to have other capabilities beyond wireless network access.

In addition, we will explore other issues arising from the use of location-aware systems, in particular:

- how to distinguish interest from simple proximity
- how to incorporate a 'location history' into context
- how to infer a change of position in the contextual sense from changes in physical location reported by a location service
- how location-driven changes to content or services can best be presented to a mobile user.

Our testbed aims to simulate a visit to an art gallery; however, most of these points will be applicable to other context-aware services and scenarios.

References

Bauer M, Becker C and Rothermel K (2001). Location models from the perspective of context-aware applications and mobile ad hoc networks. In *Proceedings of the Workshop on Location Modelling for Ubiquitous Computing, Atlanta, Georgia*, 35–40.

Ekahau (2005). *Website*. At www.ekahau.com

Jones GJF and Brown PJ (2002). Challenges and opportunities for context-aware retrieval on mobile devices. In *Proceedings of the SIGIR Workshop on Mobile Personal Information Retrieval, Tampere, Finland*, 47–56.

Lonsdale P, Baber C, Sharples M and Arvanitis T (2003). A context-awareness architecture for facilitating mobile learning. In *Proceedings of the MLEARN Conference, London, 19–20 May*. London: Learning Skills and Development Agency, 36–37.

Small J, Smailagic A and Siewiorek D (2000). *Determining user location for context aware computing through the use of a wireless LAN infrastructure*. Pittsburgh, PA: Institute for Complex Engineered Systems, Carnegie Mellon University.

The impact of innovation in medical and nursing training: a Hospital Information System for Students (HISS) accessible through mobile devices

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Abstract

In the HISS (Hospital Information System for Students) project, run by the Campus Bio-Medico, a university in Rome, students of medicine, nursing and dietetics practising in the wards were trained to use handheld devices connected through a wireless local area network (WLAN) to record patients' data. Besides learning this new technology and applying it to access freely teaching resources from any place on the campus, the students were able to design new user interfaces for accomplishing daily tasks. The work done by dietetics students was a good basis for the development and implementation of a real-life solution at the University Hospital.

Keywords
mobile training, ubiquitous computing, adaptive user interface, impact of innovation

1 Introduction

Learning on the job has always been considered a fundamental approach for medical-related professions. An important part of the teaching is accomplished on the wards, while visiting patients. The typical way of memorising what is said or done by the teachers, nurses or physicians is to take a written note in an exercise book. This leads to unstructured data and makes it difficult to access specific information quickly. Further work is usually needed to reorganise the notes in a practical way for easy recovery of any part of it.

At the Campus Bio-Medico, a university in Rome, we introduced wireless networks and portable devices at the beginning of 2003, starting a number of projects for assessing the use of this technology. One of them emphasises the use of handheld computers (Palmtop and Tablet PCs) for training students of medicine, nursing and dietetics. The project was financed by an HP Applied Mobile Technology Solutions in Learning Environments grant. This was the only Italian project in a list of 40 projects funded worldwide. It was presented at the HP Labs in Palo Alto, California in September 2003 to all the other institutions that received a grant.

We installed wireless devices so that from every room of every ward a connection could be made to a separate LAN – different, for security reasons, from the HISS wireless local area network (WLAN). Each student participating in the project was equipped during training sessions with a WLAN-enabled HP iPAQ 5500 capable of fingerprint authentication. Some of them, especially the teachers (nurses and physicians), used an HP Tablet PC.

Attention was paid to feedback: a system was set up for collecting comments, bug notices, proposals and other information from the users. Experienced tutors closely followed the monitoring activity so that quantitative data was integrated with qualitative evaluations directly gathered from observation of student and teacher activity.

We had many goals: first of all, we wanted to teach our students the new technologies they will encounter in the future while working in hospitals. We also wanted to give them a better tool for learning the medical topics they were dealing with on the wards. We also wanted them to define the user interface for medical applications on handheld computers. This proved popular with students and medical staff. Instead of involving in the interface design actual nurses and doctors, whose time is expensive and who are always busy in their daily tasks, we used feedback from the students to develop an actual Hospital Information System (HIS) accessible through mobile devices.

From the learning point of view, we were interested in examining whether the students using handheld computers were achieving better results in their examinations than those taking notes in the traditional way.

We soon realised, however, that this last goal was too complex to accomplish because too many factors are involved in the learning phase, and comparing groups with and without handhelds requires many students and an enormous amount of data.

2 Project development

2.1 A task-oriented solution

Our first chore was to convert the written note into an Electronic Patient Record (EPR) suitable for handheld computers. We developed the structure and contents of the EPR by studying some existing models like Ward-in-Hand (Ancona *et al*. 2000) and Bedside Florence (Policlinico Gemelli 2002) and by addressing the specific needs of our 120-bed University Hospital. We held regular meetings with the teachers, tutors, physicians, nurses and dieticians in charge of their departments. We also followed the daily hospital activity of the three main groups of actors: physicians, nurses and dieticians. We concentrated on the tasks that might require a mobile device: we selected all the information that they usually wrote at the bedside, excluding therefore other longer data, such as the patient's admittance and discharge letters which can be better written on a desktop computer. Furthermore, we based our analysis on the existing paper models in order to reduce the impact of innovation and achieve a higher degree of acceptance by both teachers and students.

2.2 An adaptive users' interface

After defining the main roles of the people involved and the tasks that they normally carry out, the main problem was content adaptation, mainly due to challenges posed by the features of the mobile devices and the frequent changes in the interface definition. We were aware that the development process in writing the software had to be adaptive, because the students would discover new solutions and re-define the structure many times.

Since we were not bound to a real production schedule and we had no strict deadlines, we were free to try different solutions [online and offline; XML and RDBMS (Relational Database Management System); access trough WLAN, GPRS, UMTS; interface adaptation for Pocket and desktop PCs]. Eventually we based our system on ASP.NET, C#, XML and SQL Server.

The web-based application, accessible through a wireless LAN (WLAN), included both generic and specific data-entry masks. By using XML, we built 30 different masks by simply combining a few tags: <Section>, <Title>, <Voice>, <VoiceName>, <Value> for the different structural parts; <SmallText>, <MediumText> and <BroadText> for data input; <Drop> corresponding to the object DropDownList in ASP.NET and <Check> corresponding to CheckBoxList in ASP.NET (see **Figure 1** opposite).

The possibility of rapidly changing the contents via XML schema, without varying the code, allowed us to improve the application day by day: for example, in 10 days of work with the physicians, the patient history module changed four times and the general examination module five times.

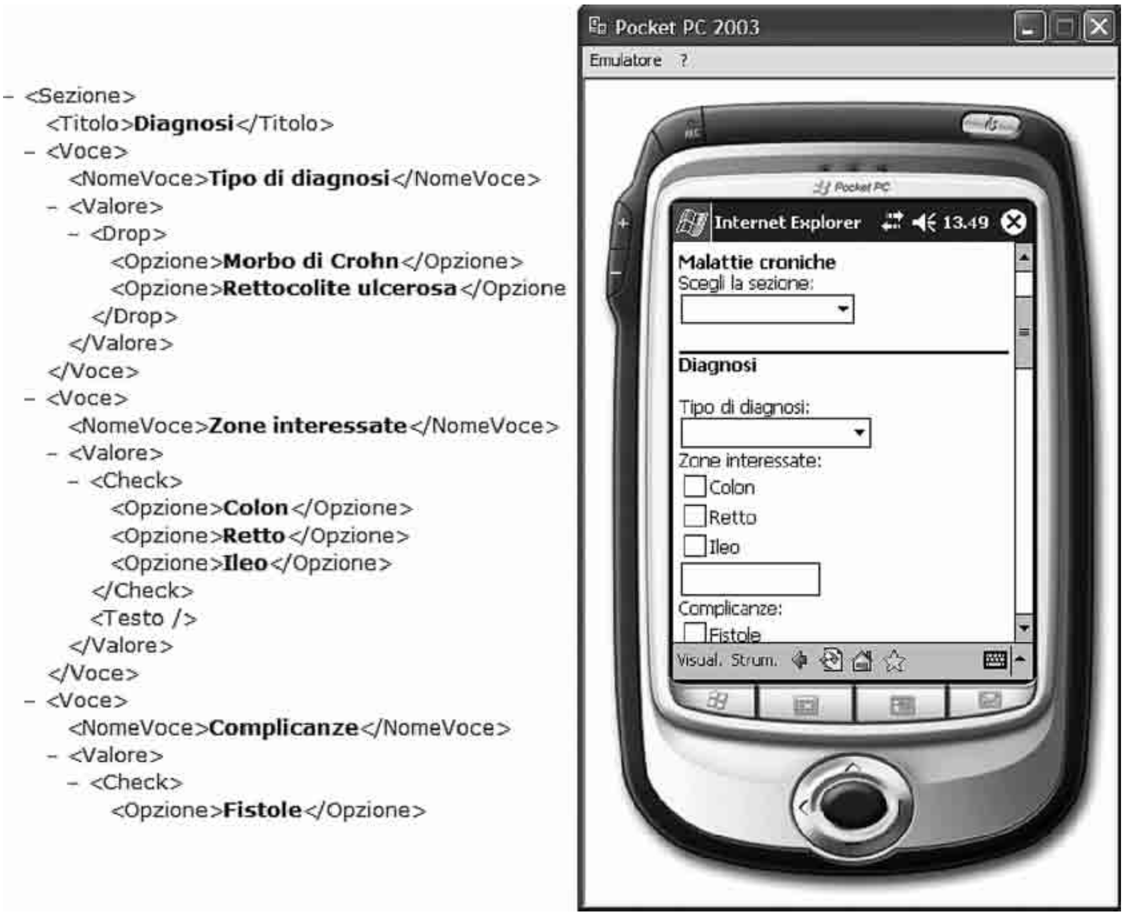
Apart from content adaptation, we carefully studied the way in which to present it to the users. The design involved ergonomic and technical factors. The interface, very simple at the beginning, was enriched thanks to users' feedback. The main innovations were as follows:

- multiple sections masks to avoid overlong HTML pages
- substitution of text boxes with drop-down lists or checklists of options
- distinction between frequently and less frequently used options
- text boxes of different sizes (small, medium and large) at the end of the lists to insert additional information (values, observations, descriptions)
- different modules to modify or read the recorded information
- an automatic view of the clinical information requested by a specific department.

In the final implementation, there are three ways of collecting information from a patient: write into a free text box; search a (complete or partial) string in the database; answer a multiple sections mask with drop-down lists, checklists or text boxes based on XML schema language.

Our next goals will be: full adaptation capability and context awareness – that is, the content server could transparently deliver information in a format suitable for a specific device and user; and standardisation of the recorded clinical information, beginning from the classification of pathologies – which is now based on the Italian version of ICD9–CM (US Public Health Service diagnostic code) – in order to apply HL7 (the Health Level Seven standard). We are aware that the final implementation of any record system must be based on actual tasks and attitudes in the particular healthcare environment (Rossi Mori, Consorti and Ricci 2000).

Figure 1 XML data entry visualised on the Pocket PC



2.3 Ubiquitous access

To improve network performance and availability, we tested HISS access through heterogeneous networks. Our approach was based on the emerging Mobile IPv6 protocol, which provides the following benefits: management of mobility at the network layer, allowing network applications to be unaware of changes in the network; ease of use and configuration so that the user does not need to change anything when moving from local to cellular wireless networks.

Our Mobile IPv6-enabled clients can now seamlessly access HISS through both wireless access points and GPRS or UMTS VPN (Virtual Private Networks) without changing the session or relogging. A network interface monitoring module in the client device traces the signal level of wireless interfaces, as well as the presence of wired connections, and triggers the handoffs from one interface to the other when needed. In order to minimise changes to the existing hospital network and to allow access to IPv4 hosts, we developed a NAPT–PT (Network Address Port Translation + Protocol Translation) IPv6–IPv4 transition mechanism that translates IPv6 data packets into IPv4 packets and *vice versa*. This allows a transparent communication between IPv6 nodes (mobile clients of the HISS environment) and the IPv4 nodes (legacy platforms of the existing Hospital Information System). The main benefit of this approach is simplicity: the mechanism is easy to configure, since clients need only to use a DNS server that supports IPv6 addresses.

We also evaluated transport protocol performance during handoffs among heterogeneous networks as well as usability (user perception of network performance in a real environment, wide-area access to HISS so doctors can follow up on patients from home, etc). So far, we have implemented mobile access on Tablet PCs running Linux, since Windows Mobile does not yet completely support all mobility protocols. In the future, we plan to extend it to other operating systems, devices and interconnection technologies (eg Bluetooth).

2.4 Formal training and informal education

We monitored students using palmtop devices during their training in the hospital, which is a quite different activity from learning in a classroom. As previously stated, we did not monitor their improvement in learning, but we did analyse how they managed the new devices and what effect this training had on activities within in the hospital.

Since the system is not a mere simulation, but a database with real cases, access to the data was restricted to students and their teachers, strictly following the Italian privacy regulations. At first, the students were trained to convert paper recordings into electronic recordings, starting from data retrieved from the actual Hospital Information System. In the second phase, they operated directly at the bedside, while admitting patients.

We tried different ways of collecting data (online and offline) and we used many iPAQ 5500s and some Symbol PPT 2800s. We found that users tend to prefer a smaller device, with colour display, to a faster one (usability seems more important than performance). The comparison between offline and online activity offered interesting results. In the offline case, the software on the handheld device required synchronisation with a desktop PC. Thus, the 'back office' work was much harder. But from the point of view of the users, the offline solution avoided all the problems related to network performance. Therefore we envisage a new scheme for the future: data is saved offline anywhere and automatically synchronised as soon as the device is on an active cell.

Apart from the modules created for the project, which were accessible online, the students learned to use all the software installed on the iPAQ 5500 (including recording verbal notes) and other trial applications (HanDBase, Medical Pocket PC) which were selected and installed by bioengineering students. We also acquired Pocket PC versions of medicine manuals, like the Washington or Harrison manuals of medical therapeutics. An external company was commissioned to create a specific database listing the commercial names of drugs and how they work/should be prescribed, and this was personalised according to the users' needs. These resources were very useful, not only for the students, but also for their teachers: it was an application of continuing medical education.

In recent years we have been producing streaming video-based lessons for nurses in order to give them access to university-level resources and the capability of reaching the Laurea level (Campus Bio-Medico was the first Italian university to establish a university-level course for nurses). We later adapted these videos in order to stream them on handheld computers so that a nurse in a ward, during a relatively calm period (such as a night shift) can easily access the video-on-demand library of lessons. Campus Bio-Medico has also produced video-based tutorials for the VAKHUM project, funded by the European Commission (EC), which deals with 3D kinematics (study of motion) of the human skeleton (Van Sint Jan, Crudele and Gashegu 2003).

3 Users' feedback on wireless training

The evaluation methodology was based on users' observations, interviews with them and questionnaires filled in by students and their tutors. Furthermore, we tried to monitor the users' feedback using categories created by Everett Rogers, a theorist who spent over 30 years studying the diffusion of innovations, from qwerty keyboards to new agricultural methods in developing countries. According to Rogers (1995), the characteristics of an innovation, as perceived by the members of a social system, determine its rate of adoption. The five attributes of innovations are: (1) relative advantage; (2) compatibility; (3) complexity; (4) trialability; (5) observability.

Interesting results came from a test submitted to all the first-year dietetics students. The students were asked to indicate the main advantages and drawbacks of using a Pocket PC instead of a paper questionnaire. The majority of them indicated two main advantages: speed in finding the answers; and time spared in the transcription of data from paper to PC. Usability was also indicated as one of the factors in favour of a handheld device: the palmtop computer does not need a stand and it is not 'uncomfortable' (ie not heavy to carry in comparison to a normal PC). Furthermore, 80% of the students interviewed thought that the presence of a keyboard would not help them in data entry. Thethree main requirements for acceptance of an innovation (advantage, compatibility and acceptable complexity) were therefore fulfilled.

The other two indicators: trialability (the degree to which an innovation may be experimented with on a limited basis before making an adoption/rejection decision); and observability (the degree to which the results of an innovation are visible to others) – were considered less important by the students interviewed.

Among the nursing students, great importance was given to the ‘relative advantage’ factor. In the first phase, only 60% of them felt that the the use of PDAs was advantageous to them. Since the attitude of some tutors towards the HISS project was negative, the students’ feelings may have been biased. In this case, we had to work on the tutors to achieve good results with the students. Only when the tutors began to perceive the innovation as being better than the activity it superseded (writing on a piece of paper and then rewriting it on a PC, or delivering it to the physicians), did they motivate the students to use the new system.

A crucial indicator for PDA acceptance was ‘accuracy’. We demonstrated to the tutors that students using handheld devices for data entry in structured masks were more accurate than those writing on a blank piece of paper; the first group noticed more things (having different questions to answer) and were more precise.

The most critical response came from the medical students. The complexity of the tasks and the different approach to data entry contributed to a very low degree of acceptance of the new technology. Therefore, after an ineffective extensive phase (involving all the students in all the wards), we tried an intensive approach. A pilot project started in the departments which had shown a more positive attitude during the first phase – general surgery and cardiology. All the medical staff were involved, not only the students and their tutors. This phase showed that the presence of a leading authority figure is a key element for the acceptance of innovation: the fact that the directors of both departments were keen on using the devices motivated all the staff.

4 Conclusions

The HISS project, which was carried out in our university campus during the academic year 2003/04, achieved the following goals:

- enhancing the level of technology in the hospital by improving accessibility to the information system at different levels (students, nurses, physicians) through mobile technologies
- improving 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
- achieving a deeper comprehension of patient data security issues
- facilitating the requirement analysis of mobile applications
- helping with performance evaluation.

The iPAQs were used by 110 students (in different departments), recording data relating to more than 1500 patients to accomplish 30 different tasks. The medicine students entered 495 records; the nursing students 243; the dietetics students 193; while their tutors entered 919.

The positive effects of the project went beyond our expectations. Two companion projects started, driven by the enthusiasm of some members of staff: the first one, for the surgery department physicians, has completely changed the way that rapid data entry is done at the bedside – previously this was done on a sheet of paper placed on a wooden tablet. The second project, in collaboration with the Campus Information System software developers, is carrying out the complete conversion of the record of all dieticians’ activities (such as bedside–kitchen communication) to an electronic version.

We feel that other institutions may benefit from our experience by being encouraged to use their students as generators of specifications for real-life software applications.

Besides being the acronym of a system for students, HISS became a powerful metaphor: the ‘hiss’ – ie the whisper, the buzz – spread and involved more people and more tasks than expected.

5 Acknowledgments

We thank HP for providing all the hardware for the project. Special thanks are due to Andrea Riccio, who wrote most of the software for HISS and produced his Laurea thesis with the results of the project. Thanks also to all the tutors who patiently followed their students while working with the handheld devices.

References

Ajzen I (1980). *Understanding attitudes and predicting social behavior*. Englewood Cliffs (NJ): Prentice–Hall.

Ancona M, Dodero G, Gianuzzi V, Minuto F and Guida M (2000). Mobile computing in a hospital: the WARD-IN-HAND project. In *Proceedings of the ACM Symposium for Applied Computing, Como, 19–21 March*, 554–556.

Bernaschi M, Cacace F, Cinque M, Crudele M, Iannello G and Venditti M (2004). *Interface design and mobility in ubiquitous access to HIS*. Paper presented at the Medicon Conference, Ischia, 31 July–5 August.

Karahanna E, Straub D and Chervany N (1999). Information technology adoption across time: a cross-sectional comparison of pre-adoption and post-adoption beliefs. *MIS Quarterly*, 23, 183–207.

Munoz MA, Rodriguez M, Martinez-Garcia AI and Gonzalez VM (2003). Context-aware mobile communications in hospitals. *IEEE Computer*, 36(9), 38–45.

Policlinico Gemelli (2002). *Wireless ward system allows nurses to record and retrieve data instantly at patients' bedside*. At www.microsoft.com/resources/casestudies/CaseStudy.asp?CaseStudyID=12245, accessed 31 January 2002.

Rogers E (1995). *Diffusion of innovations*. New York: Free Press.

Rossi Mori A, Consorti F and Ricci F (2001). Sharing clinical information. From local EPR to task oriented solution. In *Proceedings of the 4th European Working Conference on Electronic Health Care Records, Aix-en-Provence, 5–6 November*.

Van Sint Jan S, Crudele M and. Gashegu J (2003). Development of multimedia learning modules for teaching human anatomy: application to osteology and functional anatomy. In *The Anatomical Record Part B: The New Anatomist*, 272B(1), 98–106.

A system for adaptive platform-independent mobile learning

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Abstract

In this paper we present our work on the extension of a state-of-the-art e-learning system – the Intelligent Web Teacher (IWT) – to support multimodal mobile access in order to offer a complete set of learning experiences, services and models that are able to fit the complex and variegated mobile world. The extended platform can offer customised e-learning experiences depending on the type and capabilities of the user's mobile device. After a brief overview of the IWT e-learning platform, the paper describes how we approached the extension of IWT to provide browser-, SMS- and voice-based interactions. Some first experimental results are then given in the last section. The work described here was realised in the context of the EC-funded m-learning project.

Keywords
e-learning, ITS (Intelligent Transportation Systems), mobile technologies, SMS, IVR

1 Introduction

The spread of the use of mobile devices and technologies offers great opportunities for the e-learning community. New scenarios, didactical models, learning experiences and services have to be designed for this new category of user. Learning may now become, as never before, 'when you want'; but also, and this is the potential of mobile technologies, 'where you want' – in the street, on the underground train, when it is necessary or when there is enough time. Moreover, mobile technologies permit provision of continuing education/training to those users who are not taking part in traditional education, but have a mobile phone and use it every day.

The mobile users' community is a complex and variegated world, characterised by different devices and technologies which are constantly changing. Technologies range from highly diffused SMS (Short Message Service) to MMS (Multimedia Messaging Service); from WAP (Wireless Application Protocol) to HTTP (Hyper Text Transfer Protocol); and from GSM (Global System for Mobile Communication) through GPRS (General Packet Radio Services) to UMTS (Universal Mobile Telecommunications System). Devices vary from mobile phones to personal digital assistants (PDAs), from new-generation Smartphones to laptop computers.

Our aim is to extend an existing e-learning platform, the Intelligent Web Teacher (IWT), in order to allow the design and delivery of significant learning experiences via a huge set of mobile technologies. This was done in the context of the EC-funded m-learning project.

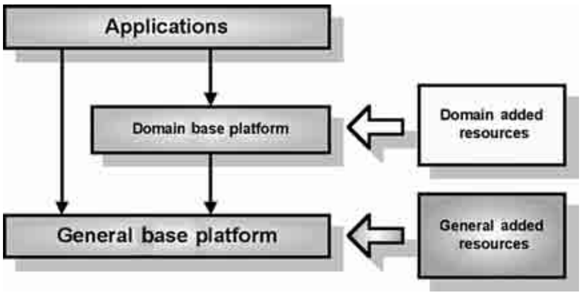
2 The IWT e-learning platform

Every didactic/formative context requires its own specific e-learning solution: not only with regard to the content, but also the didactical model, formative modules, applications and tools. These necessities usually imply hard work for analysts, engineers and developers. IWT (Capuano, Gaeta and Micarelli 2003) solves the problem, thanks to an extensible solution which can become the foundation of a virtually infinite set of applications for either traditional or innovative e-learning.

Conceptual and technical choices in design and development have brought about an architecture that can be extended both in terms of services and learning object typologies through the installation of added components. Indeed, IWT allows the user to add to the platform new services written *ad hoc* for the system by previous implementations of suitable plug-in software that is compliant with system specifications.

As illustrated in **Figure 1**, the general IWT platform offers a set of generic management services for content, courses, collaboration and administration. Some of those services are fixed (general base platform) while others are optional (general added resources).

Figure 1
General IWT architecture



IWT allows the user to manage contents like learning objects, tests, business games, etc. Furthermore, given the extensibility of the platform, it is possible to add new typologies of resource at any time, without altering the system. IWT also allows the users to manage courses. Two kinds of courses are supported: simple and intelligent. The intelligent course (Capuano *et al*. 2002) can be customised according to the real needs and preferences of the students and fully applies the principles of student-centred learning.

Given a set of didactic objectives chosen by the teacher on the domain ontology, the intelligent course is able to generate the best learning path for each student starting from its student model, based on acquired knowledge about the student and his/her learning preferences. Different students with the same didactic objective will thus have different courses generated by the system.

IWT also allows the users to collaborate and communicate with each other via messages, discussion forums, chat, content sharing, videoconferencing, etc. IWT applies three different models: the knowledge model, the student model, and the didactical model and is paradigm-based on a pattern adapter to allow extensibility. IWT is built completely using Microsoft .NET technology.

3 Browser-based interaction

Users who have HTML-enabled mobile devices may access a subset of IWT functionalities. Content and layout (see **Figure 2**) are automatically adapted by the IWT engine which recognises what kind of device users are employing for the connection. This was achieved by adopting the Microsoft Mobile Internet Toolkit (Lee 2002) which extends the Microsoft .NET Framework with server-side technology, allowing the delivery of content to a wide variety of mobile devices including mobile phones supporting Wireless Markup Language (WML) and compact HTML (cHTML), HTML pagers and PDAs like the Pocket PC.

Figure 2
IWT interfaces for mobile devices

Supported IWT functionalities on the mobile browser include course subscription, course delivery and basic collaboration features (like chat, forums and messaging). Such functionalities are synchronised with those available on the PC web browser. It means that people are able to communicate with each other even if they are using different kinds of device.

4 SMS-based interaction

SMS is the most common and frequently used mobile service: it is present in every kind of mobile device and offers the possibility of reaching all mobile users. Our idea was to build courses composed of SMS 'pills' – short textual learning objects – together with multiple-choice tests delivered by SMS. The learner can answer tests by simply replying to the test SMS question with an SMS containing the answer. The system tracks the answer received from every single learner, verifies the results and sends him or her a new SMS containing the test results and suggesting improvements.

Figure 3 Extended IWT architecture for SMS support

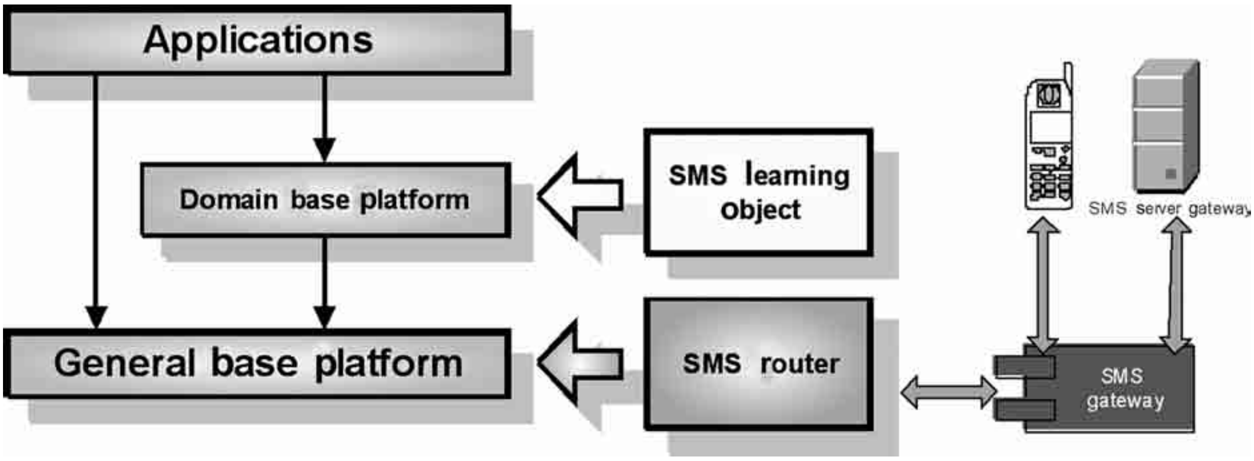
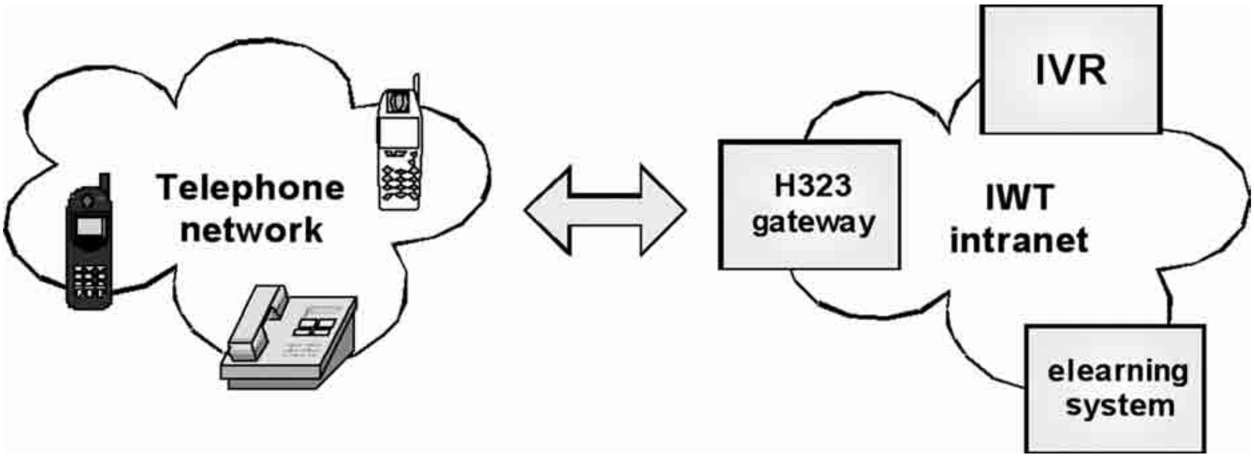


Figure 4 Adoption of voice-based interaction in IWT



To allow the management of these new types of learning object, we created several new IWT resources (see **Figure 3**): SMS Test, SMS Textual and SMS Course. To allow the learner to send/receive SMS, we have extended the IWT services with an SMS router module that interacts with an SMS gateway. An SMS gateway is a simple SMS-enabled mobile phone or an SMS server accessible as a web service.

5 Voice-based interaction

Last but not least, the system is also able to provide voice-based interaction. The learner can access the system with a normal phone call and can navigate the IWT portal using IVR (Interactive Voice Response). A synthesised human voice reads a simplified version of the portal content and the user can browse by dialling on the phone keyboard.

This access method was achieved by connecting to the IWT general base platform a software-based IVR facility linked to the telephone network through an H323 gateway (see **Figure 4**). A new version of the IWT portal was then provided in the form of a navigation tree. Each node of such a tree represents the current position of the learner, while each branch is a possible choice at that point. Some information features (bulletin and news reading, course lists) and collaboration features (messaging, voice chat with a tutor) were then implemented using voice-based interaction.

6 Preliminary experimentation results

The mobile browser-based interaction described in section 3 is under trial, with around 200 users from the UK, Italy and Sweden taking a set of courses on literacy and numeracy.

In collaboration with Albatros, an organisation from South Italy that works for the social integration of foreign and dialect-speaking people, we are currently starting a new trial based on an SMS first-level Italian language course, again using voice-based interaction for collaboration activities.

The final results of both trials are not available yet. The first impression is that users are generally highly motivated when using mobile technologies for learning, with a particular emphasis on SMS technology, which seems to be more effective and simple than browser-based interaction which still presents connection problems.

References

Capuano N, Gaeta M and Micarelli A (2003). IWT: una piattaforma innovativa per la didattica intelligente su Web. *AI*IA Notizie*, XVI(1), 57–61.

Capuano N, Gaeta M, Micarelli A and Sangineto E (2002). An integrated architecture for automatic course generation. In *Proceedings of the International Conference on Advanced Learning Technologies (ICALT), Kazan, Russia*, 322–326.

Lee W (2002). *Developing mobile applications using the Microsoft Mobile Internet Toolkit*. At http://devx.com/wireless/Article/10148, accessed 2 December 2002.

Mobile learning = collaboration

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Abstract

Communicating is what mobile technologies do best!

Feedback from learners and tutors in the m-learning project trials has taught us that users enjoy the content, but they love the collaboration.

One of the key challenges that the m-learning project addressed has been the development of a collaborative learning tool called mediaBoard. This allows learners to collaborate using text and picture messaging, contributing to a shared website that everyone has helped to make.

In this paper, we will review how mediaBoard works.

Keywords
mobile learning, mediaBoard, MMS, SMS, picture messaging, mobile phone, collaboration, communities of practice, P900, XDA2, PDA

1 The m-learning project

The m-learning project is a 3-year pan-European collaborative research and development (R&D) programme supported by the European Union (EU). The consortium is a partnership of organisations – the Learning and Skills Development Agency (LSDA), Cambridge Training and Development (CTAD) and Ultralab from the UK; Lecando from Sweden and the Centro di Ricerca in Matematica Pura ed Applicata (CRMPA) from Italy – combining skills in pedagogy and technology.

The project has developed prototype products and innovative approaches designed to support learning, particularly literacy, numeracy and life and survival skills, using handheld devices such as mobile phones and palmtop or pocket computers. A key objective is to engage with and motivate young adults who are not engaged in education or training, particularly those who are unemployed or homeless.

The project has funded the purchase of 100 mobile devices (P800s, P900s, XDA2s), which were used by 300 learners in the three partner countries.

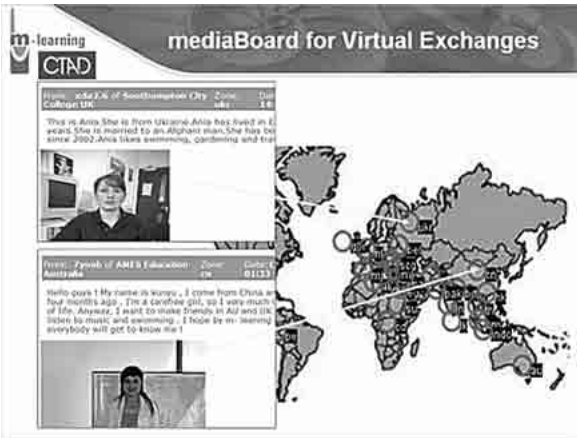
2 Learning with the mediaBoard

2.1 Context

The mediaBoard (see **Figure 1** overleaf) encourages learners to use a mix of technologies – mobile phones (with and without cameras), SMS, MMS, mobile and regular web access – to contribute to online projects. Tutors can set up their own mobile event or project. These projects can be competitive (treasure-hunt style), collaborative (with differentiated tasks) or reflective [using the mediaBoard as a diary or web log (blog)]. At the time of development, there were no commercial alternatives. Recently several web logging (blogging) websites have sprung up which accept text and picture messages. These deal with the same technology challenges, though they use a different ‘play’ model, and there is less emphasis on the notion of a community of practice. This makes for an interesting comparison with our thoughts on the mediaBoard.

Current users include travellers, asylum seekers and inner-city learners from the UK and Sweden.

Figure 1
Sample mediaBoard



2.2 Learning

'Content isn't king – community is sovereign' (Heppell 2003). The learning developed by the project falls broadly into two categories: individual (tests, quizzes, self-assessments) and collaborative (the mediaBoard). Collaborative learning allows for a more cohesive, social constructivist style of learning. The mediaBoard supports a 'community of practice' approach, in which a group of learners feels involved and is able to use the technology as a facilitator for its own creative ideas (see Lave and Wenger 1991; Wenger 1998). The learning can be made more fruitful as it is extended over time, with sessions for preparation followed by sessions that use the information gathered for further activities. Learners' affective and social needs are addressed by engaging the imagination and promoting exploration and creativity within a non-threatening environment. This concept and practice of learning is offered as a counterbalance to the current UK focus on a more target-oriented approach to learning; and also as a means of engaging learners for whom more traditional methods have failed.

2.3 The challenges

Challenges are both technical – some very rural areas do not have sufficient connection to a network/supplier to make use of the mediaBoard feasible; and practical – there is an expectation in learning of this kind that both tutors and learners will be enthusiastic users of new technologies, but this is not always the case. Training of tutors and learners is a key element in this style of learning. There is also the challenge of developing a community of practice: learners need to develop their own agendas for use of the mediaBoard, so that they are genuinely involved in their own knowledge creation.

3 Case studies

Case studies that have been conducted using the mediaBoard include:

- The Southampton Timeline: a mediaBoard was used to explore the history of immigration to Southampton
- College Open Day: this case-study used a mediaBoard as part of an induction week in a college
- An Italian Park: a mediaBoard was used for language learning.

4 References

Heppell S (2003). Keynote speech. MLearn Conference, 19–20 May, London, UK.

Kowch E and Schwier R (1997). *Characteristics of technology-based learning communities*. College of Education, University of Saskatchewan. At www.usask.ca/education/coursework/802papers/communities/communities.htm

Lave J and Wenger E (1991). *Situated learning. Legitimate peripheral participation*. Cambridge: University of Cambridge Press.

Rogoff B, Turkanis CG and Bartlett L (eds) (2001). *Learning together: children and adults in a school community*. New York: Oxford University Press.

Wenger E (1998). Communities of practice: learning as a social system. *Systems Thinker*, June issue. At www.co-i-l.com/coil/knowledge-garden/cop/lss.shtml

Tablet technology for informal collaboration in higher education

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Abstract

This paper describes a trial of Tablet PCs with students in higher education. The participants were provided with a set of collaboration and knowledge-management tools, and encouraged to explore the Tablet PC as support for informal aspects of their learning, particularly in collaborative project work.

Keywords
Tablet PC, informal collaboration, higher education

1 Introduction

A study was undertaken to explore the possibilities afforded by wireless Tablet PCs in higher education, with particular regard to the informal and collaborative uses of the device. The work is complementary to, but separate from, other research into using technology in formal learning situations, such as ActiveClass (Ratto *et al*. 2003). Building on the results of an earlier project using Pocket PCs (Corlett *et al*. 2004), this trial set out to create an environment in which best use of the tablet technology could be achieved. Students recruited to the trial were given a range of software and hardware tools for an open-ended investigation of their learning activities.

2 Method

2.1 Participants

Seventeen students were recruited to the trial from a third-year engineering course in which, as part of the course, they form teams of six or seven to conduct a year-long design project. The project requires effective collaboration and a high level of cooperation on the part of the students. Three teams opted to join this study, each member receiving a Tablet PC to use as their own until the end of the academic year.

In addition, the teams' supervisors and mentors also received a Tablet PC and could use this to communicate and work with their teams. A further two students from the same cohort joined this study, but without the rest of their team.

2.2 System specification and supporting infrastructure

The Tablet PCs used in the study were a mixture of clamshell and slate-only form factors. All students within a specific team were equipped with the same model. External keyboards were provided with the slate-only tablets. Additionally, one team was equipped with audio headsets and a USB 'webcam on a stick'. One team started with the slate-only form and then changed to clamshell for comparison.

Software provided to the students included the entire Microsoft Office 2003 Professional suite, plus OneNote (tablet-optimised note-taking and organising tool). Mindjet MindManager for Tablet PC was installed to provide concept-mapping features that integrate with the Office products. Students were free to install any further applications of their choice.

In response to the outcomes of the earlier trial, a central portal (Microsoft SharePoint) was set up to provide technical support, course information and communication tools. Each team also had a private portal site with discussion, document-sharing and tracking, time-management and publishing tools. The private portal helped to provide cohesion and a persistent workspace to provide the teams with greater mobility.

A wireless network (802.11b) is available throughout the department and across some of the open spaces on campus. The department operates an Exchange Server for personal and shared information management. Each participant had an Outlook client to connect to this.

2.3 Data collection and analysis

Data was collected from students via questionnaires issued before, during and after the trial. Questionnaires aimed at particular users or activities (eg people who additionally use a PDA) were issued on an *ad hoc* basis. Students were also encouraged to provide feedback at any time. Observations, particularly of team sessions, were conducted and focus groups were used after the trial to expand on problems, observations and suggestions raised in the questionnaires or feedback.

3 Outcomes and results

Initially, participants were harder to recruit to the trial than had been anticipated. Concerns included taking responsibility for expensive equipment, time needed to be spent in customising the Tablet PC and learning to use new software, and simply not being able to visualise the benefits. All participants owned either a desktop or laptop PC, in which they had already invested time and money, and so some saw no need for another computer.

Learning support for the project was described as good by all participants – the only suggested improvement was more tutorials for help in using unfamiliar software.

The teams that took part varied in their enthusiasm and willingness to try new activities. However, the team that initially showed most reluctance about taking part became the most spontaneous innovators. This group used internet text and audio messaging to liaise with their supervisor and communicate with one another. They developed technology-enhanced team meetings in which members used their Tablet PC as a shared whiteboard and collected audio and video that could be embedded in their notes.

3.1 Generic usability issues and form factor

The study revealed the obvious usability issues relating to hardware and software, ranging from weight and battery life to slow performance and unreliable synchronisation of files to the departmental file server. Several students intended to use their device out of doors, within the wireless network, but found that screen brightness made this impossible. Users were disappointed not to have a full choice of customisation, though found it useful on occasions to have the same look and feel on the departmental desktops as on the Tablet PC.

There were considerable differences between the slate-only and clamshell designs. All students reported that a keyboard is fundamental to making full use of the device. Five of the six students who switched to a clamshell part of the way through claimed that they used it more and carried out a wider variety of tasks than with the slate-only device. The clamshell offered better features, greater comfort and more flexibility.

Six students were equipped with a wireless Pocket PC in advance of the Tablet PC trial and were allowed to keep it throughout to make a comparison. They all stopped using the Pocket PC completely after receiving the Tablet PC, citing the relative usefulness of the tablet as the main reason, despite the advantages of the smaller form factor with the Pocket PC in certain situations.

3.2 Patterns of use and collaboration

By the end of the project, four of the 17 students had stopped using their Tablet PC. Three of these had only done so once all timetabled teaching was complete, with only one giving up before that. All four had the slate-only model. Ten students were still using their Tablet PC at least once a day until they handed it in.

The most popular activities were: (1) e-mail; (2=) creating documents, browsing, listening to music; (3=) reading, taking lecture notes, taking meeting notes; (4) watching video; (5) programming; (6=) internet text messaging, annotating slides; (7=) keeping a record of work, managing time.

Prior to the study, all teams had set up an internet group account for discussion and document sharing. All teams switched to using the SharePoint Portal, since it offered greater data capacity and better customisation. Shared files could also be created and accessed directly from the productivity suite on the Tablet PC. While discussion was also popular, other features of the portal such as calendar, contacts and announcements were not widely used. Both focus groups unanimously agreed on the usefulness of such a team workspace. Instant internet messaging was used by all participants for learning and leisure. Multi-user chat was used by seven participants.

Team meetings were observed and followed up with a short interview. Activities introduced to the meetings as a result of the technology were: instant minute-taking and sharing; making an audio recording of the meeting (especially of value to those working in a second language); using a shared whiteboard; show-and-tell demonstration of project deliverables; file transfer; and immediate follow-up of requests for e-mails and other information.

3.3 Analysis of applications/and tools

Despite frequent complaints that the PCs were slow and lacked memory, a number of students installed a range of powerful programming and imaging tools that they used on a regular basis. Only one student claimed to have installed any games, though nine out of 17 placed a media player in their five most frequently used pieces of software. Many watched videos downloaded from the internet, with two admitting to doing so during lectures.

OneNote, the note-taking tool, was listed among the five most frequently used tools by 16 of the 17 respondents, with seven claiming it to be the most useful individual tool.

Participants were asked to list the top three benefits of having had a Tablet PC, and these benefits were then grouped into categories. Wireless communication, anytime/anywhere access and note-taking were rated in the top three by 13, 12 and 11 of the 17 participants, respectively. All other benefits were suggested by only one person, with the exception of style/novelty claimed as a top benefit by three students.

The concept-mapping tool was not used by any students for any purpose other than to try it. In the focus group, the consensus was that it would be a very useful tool, but it appeared to be particularly difficult to use. However, none of the students took up the offer of a demonstration session early in the project. Most were surprised, when shown, how little effort it took to create basic concept maps, and suggested that the software needed redesign to make this clear.

4 Conclusions and comment

Our study has found no evidence that use of a basic Tablet PC will in itself radically change or enhance student learning, although the pen interface can facilitate shared whiteboards and annotation of lecture slides among other things. The main observation from the data, backed up by feedback from the focus groups, is that the main advances are made with e-mail, instant messaging, sharing of electronic resources, etc, none of which are exclusive to the Tablet platform. Rather, it is the mobility, flexibility and robustness of a Tablet PC (over and above other form factors) that makes it possible for these powerful uses of IT to become embedded in every aspect of informal, collaborative learning. This in turn was considered by the teams to have a positive effect on their learning.

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References

Corlett DJ, Sharples M, Chan TKS and Bull S (2004). A mobile learning organiser for university students. In *Proceedings of the 2nd IEEE International Workshop on Wireless and Mobile Technologies in Education, Taoyuan, Taiwan, 23–25 March*. Los Alamitos, CA: IEEE Computer Society, 35–42.

Ratto M, Shapiro RB, Truong TM and Griswold WG (2003). The ActiveClass project: experiments in encouraging classroom participation. In *Computer Support for Collaborative Learning*. New York: Kluwer, 477–486.

The role of user scenarios as the central piece of the development jigsaw puzzle

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Abstract

This paper considers the employment of user scenarios within the context of the prototypical development of a mobile learning architecture. Through a case study, it demonstrates how scenarios have influenced the development process by focusing on the role of teachers and learners throughout different stages of the prototype development. It illustrates ways in which scenarios relate to system requirements and evaluation, and how they offer a communication strand between technical and non-technical partners. During the project, key scenarios were identified and gradually refined to become more concrete, so that eventually they could be used to evaluate the final system. Scenarios used in this way also serve to resolve the difficulty identified by Taylor (2003) of how to bring together a high-level evaluation design with implementation issues.

Keywords
user scenarios, mobile learning architecture, user trials, evaluation planning

1 Introduction

The potential domain for the use of mobile devices to support learning is wide and varied. The major aim of the EU-funded MOBIlearn project (IST–2001–37440) is to define and evaluate a pedagogically sound mobile learning environment. Taylor (2003) points out some of the inherent difficulties in achieving this aim, noting that there needs to be a discourse between the technical developers and those responsible for high-level pedagogic design – a discourse that is informative and helpful to both parties. The decision to employ user scenarios was made to fulfil two purposes. First, to assist with the process of 'envisionment' (Carroll 1995) – that is, to develop ideas about possible uses. Second, to enable progression towards field studies by providing user requirements in the user-centred context. In the context of a large and disparate set of partners, it also provided the opportunity to support dialogue between technical developers and the non-technical participants, who were responsible for requirements gathering and evaluation.

We define scenarios, in this context, as 'a story focused on a user or group of users, which provides information on the nature of the users, the goals they wish to achieve and the context in which the activities will take place' (MOBIlearn 2002). They are written in ordinary language, and are therefore understandable to various stakeholders, including users. They may also contain different degrees of detail.

Three target domains were identified for study and development. These were museums (including art galleries), health, and MBA students attending a university business course on a part-time basis. It was within these three domains that the scenarios first came to life. The first stage was to capture the expertise of partners – who came from a variety of domains with an extensive experience of teaching and learning – in the creation of situations and settings relevant to mobile learning. Pedagogic considerations were embedded in the results from this process, which led to the creation of a library of around 200 potential scenarios. It also provided a substantial list of user requirements which were represented as Volere shells and stored within a requirements database (Haley *et al.* 2004). These requirements presented the rationale of what the users wanted to be able to do.

The second stage was a calibration exercise, gathering user data from learners and teachers within the context of the domain. Questionnaires and interviews were held with people visiting the Uffizi gallery in Florence;

interviews and focus groups involved students at the University of Zurich; and future technology workshops (Vavoula, Sharples and Rudman 2002) were used with First Aiders at the Open University in the UK and students from the University of Birmingham. Outcomes from these and subsequent stages provided further requirements.

The evolution of these scenarios, remaining grounded in users and their requirements, has become increasingly important to the evolution of the system. The rest of the paper considers the development of the agreed final scenarios and explains how they have contributed to other project deliverables – in particular, how the preparation of a specific instantiation of the scenario assists the preparation of the evaluation plan for the user trials (where the term 'instantiation' indicates that the scenario is to run in a specific place, at a given time, with real users and real outcomes). Although three scenarios were developed, one representing each domain, each followed the same process: this is illustrated here with examples from the health scenario. The work is ongoing.

2 Developing the health scenario to focus on user trials

To support this process, we re-defined scenarios as 'a story focused on teachers and learners in a specific context, identifying specific activities which will be followed to achieve certain predefined educational goals'. This definition is well matched to educational activity in which a course sets certain learning objectives and goals for the students to achieve. A tutor/trainer may then define a set of activities, to take place over a period of time, which will together support the learning objectives.

The calibration exercise used future technology workshops (Vavoula, Sharples and Rudman 2002) held at the Open University: the participants were First Aiders who perform their role within the workplace environment in addition to their normal job. The workshop activity identified ways in which the use of mobile technology could support their requirements for training, skills development and practice. The resulting scenario was written to focus on their training needs and is therefore grounded in their user requirements. It is based on constructivist pedagogy and involves learner interaction focused on defined activities or learning episodes. It was planned to serve as the potential basis of the user trials, scheduled for autumn 2005. **Figure 1** gives an example of a stated requirement with related scenario activity.

Figure 1
Example of a stated requirement with related scenario activity

Requirement
First Aiders need to be able to store documents for later perusal either by themselves or their peers.

Rationale
First Aiders will be able to learn from evaluations and discussions of their prior assessments of first aid incidents.

Scenario activity

1. Gill receives a picture of a first aid event. The picture is accompanied by a text message asking her to scrutinise the picture, and using her mobile device, to file an initial assessment with the leader as to what needs to be attended to in the environment.
2. The leader is pleased with Gill's initial assessment, but notes that it differs from Peter's, another First Aider participating in the exercise. She suggests that Peter and Gill communicate with one another about their interpretations of the scene. They need to agree a plan of action.

In parallel with the development of the technical prototypes, the next step was to refine the scenarios. The need was identified for a more specific instantiation of the scenario in order to provide detail for the user trials. The Open University's first aid trainer was engaged in the process through discussions. The scenario activities were ratified and specific skills and topics worthy of inclusion in the scenario were identified. **Figure 2** opposite shows the structure of learning activities.

Figure 2
Structure of learning activities

The refined health training scenario consists of three distinct episodes which support different learner activity and collaborative activity over a period of a week.

- *the quiz* –
  based on first aid procedures and processes
- *the picture-/video-based activity* –
  based on incident assessment
- *the enactment* –
  a role-play activity based on a simulated incident.

A further episode of individual activity lasting throughout the week enables the use of self-assessment content, access to external links and the opportunity to view other related content.

The activities will cover procedures laid down for action at an emergency: CPR (cardiopulmonary resuscitation) and the recovery position.

The instantiation of the test scenarios provided details of users, content and the devices that were required. A decision was made to extend the instantiation to satisfy the needs of the evaluation process by including details of the context of use, questions to be answered during the evaluation, and the activity or task which would be used to gather responses. This stage provided an opportunity for partners who were focusing on pedagogic validity and socio-pedagogic usability to have an input into the process.

3 Added benefits of scenario use

The development of the scenarios proved to be a multi-threaded activity and revealed further benefits. We experienced difficulties in getting the non-technical partners to engage with the database and the process of gathering formal requirements. The key to overcoming this difficulty was the scenario refinement activity. There was also a need to bring together evaluators and technical partners to support the evaluation. The scenarios assisted with this by providing a grounded focus in non-technical language.

The links between services and requirements and between requirements and testing/evaluation were facilitated by the decomposition activities carried out as part of the final test instantiation. Developers were able to use the agreed scenarios to identify, plan and develop a range of services. Testing and evaluation of the developing prototypes could be planned against the required functionality of the scenarios, creating a link back to the services. **Figure 3** illustrates the matching of scenario activities with system services.

We anticipate that the process of producing the test instantiation for the scenarios will have a major benefit in driving the higher-level pedagogic and socio-cognitive evaluation during the user trials. Issues have been identified and questions defined before the system is complete and it is possible to engage in user activity. Finally, as we move towards the user trials, we hope that the recognition of their input into the scenario will entice First Aiders to volunteer as participants.

Figure 3 Matching scenario activities with system service calls

Scenario activity	Sub-activities	System service calls	Expected system response
Notification of quiz:	1 Log on to system	MD_PDA–25	Login page displayed
Team leader sends message to all the team participants informing them of the imminent quiz and the procedure they should follow.	2 Select group of users	MD_PDA–26	Correct login displays main menu
	3 Enter text message	MD_PDA–16	List of users/groups of users is displayed
	4 'Send' message		Allows selection of target group
			Place to enter text is displayed
			Option to send text

4 Conclusion

We have found that the use of scenarios in this way has many features.

- It is multi-stranded, supporting mutually informing dialogue.
- It performs a technical role in relation to requirements as specified in the database of Volere shells.
- It supports both formative and summative evaluation.
- It provides the missing link between higher-order concepts, such as pedagogy and learning objectives, and lower-level implementation aspects.
- It supports the verification of system functionality against user requirements.
- It offers a mechanism to support activities linked to user-system interaction.
- It engages users and their representatives in the development process and keeps their interests at the centre of the project.

References

Carroll JM (ed.) (1995). *Scenario-based design*. New York: John Wiley and Sons Inc.

Haley DT, Nuseibeh B, Sharp HC and Taylor J (2004). *The conundrum of categorising requirements: managing requirements for learning on the move*. Paper presented at the Requirements Engineering Conference, 6–10 September, Kyoto.

MOBIlearn (2002). *Next-generation paradigms and interfaces for technology supported learning in a mobile environment. Exploring the potential of ambient intelligence*. Project No IST–2001–37187. Technical Annex. MOBIlearn Consortium.

Taylor J (2003). A task-centered approach to evaluating a mobile learning environment for pedagogic soundness. In J Attewell and C Savill-Smith (eds) *Learning with mobile devices*. London: Learning and Skills Development Agency, 167–171.

Vavoula GN, Sharples M and Rudman PD (2002). Developing the future technology workshop method. In MM Bekker, P Markopoulos and M Kersten-Tsikalkina (eds) *Proceedings of the International Workshop on Interaction Design and Children (IDC2002)*. Shaker Verlag, 65–72.

Team awareness in personalised learning environments

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Abstract

In most of today's campus-like learning settings, students are frequently confronted with e-learning systems that do not only deliver and display learning content, but are equipped with a number of integrated tools for file sharing, communication, personalisation (personal annotations, text marking, etc) and cooperation. However, recent observations show that these functions are rarely used. One reason for not using the technological opportunities for informal communication and interaction is the poor design of such systems with respect to team awareness in learning teams. The poor support for synchronous and asynchronous communication and collaboration in today's e-learning systems has motivated the development and prototypical implementation of a context-aware team interaction support system. This offers up-to-the-moment information about the location, state and activities of learning teams, thus helping to build up awareness of the surroundings in which team learning processes can take place. In this paper, we present an extensible awareness system, which is capable of providing context information in a presentation-independent format. A team space is provided for mobile learning teams, integrating state and task awareness functionality with a means of synchronous and asynchronous communication.

Keywords
mobile learning, team awareness, context awareness, learning context

1 Introduction

Until the last few years, learning was generally conceived as a one-way knowledge transfer from a teacher to a learner, either directly or via media (eg books). This view has now largely been superseded by one where learning takes place everywhere and implicitly, thus becoming more and more informal: 'Informal learning is implicit learning, which means it is derived from direct interaction … and a range of cues given by peers and instructors that go well beyond what is explicitly being taught.' (Ewell 1997).

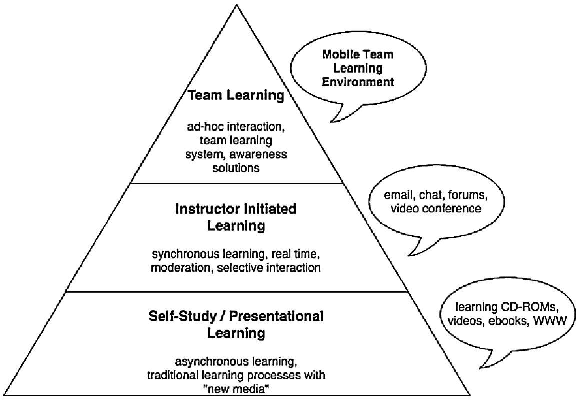
Furthermore, it has been recognised that learning is much more effective if the learned information can be put into context with the learner's existing knowledge. Hull (1993) makes the point that:

According to contextual learning theory, learning occurs only when learners process new information of knowledge in such a way that it makes sense to them in their frame of reference (their own inner world of memory, experience and response). This approach to learning and teaching assumes that the mind naturally seeks meaning in context – that is, in the environment where the person is located – and that it does so through searching for relationships that make sense and appear useful.

Both informal and contextual learning lead to learning settings, where it is no longer the case that a teacher transfers knowledge to learners, but instead learners form teams to gain knowledge by discourse and dialogue, building a sort of team knowledge that goes beyond the sum of individual understanding.

In recent years, many means to support learning processes on computers have been developed, as shown in **Figure 1** overleaf. There is a broad range of systems that enable or support presentational learning or self-study. These systems are designed to present content in a way that the learner can easily understand.

Figure 1
Computer-mediated learning



There are possibilities of presentation that could not be realised in 'traditional' presentational learning or self-study. Furthermore, instructor-initiated learning is also supported by means of computer-mediated communication like chats, forums or e-mail. At this stage, systems are not able to provide the same quality of service that could be reached in face-to-face settings, although there are many widely used means of supporting interaction.

The most sophisticated support is needed for *team learning*. Building a team learning environment which can provide the features that a physical meeting room provides is still an open issue in research. In particular, the lack of possible methods to keep the team members aware of each other's state has motivated the development of the system presented here.

1.1 Support for mobile learning teams

Ferscha (2000) has identified the following organisational systems as crucial for the successful support of effective mobile teams:

- information and knowledge management system (team memory)
- awareness system (team awareness)
- interaction systems (meeting support)
- mobility systems (mobile teams)
- organisational innovation systems (team workplace innovation).

While all of these systems are important for effective team collaboration, we will now focus on team awareness. As it is hard to draw borders between the supporting systems listed above, we will also partially cover aspects of interaction and mobility systems, as they can be enhanced utilising awareness information.

1.2 Team awareness – notion and deficits

Dourish and Bellotti (1992) proposed one of the first and most common definitions of awareness in CSCW (computer-supported collaborative work) settings: 'Awareness is an understanding of the activities of others, which provides a context for your own activity.' This general definition applies to 'group' or 'team' awareness tools, the aim of which is to convey some information about the state and activities of people within a team.

Supporting the learning process in distributed teams by awareness information has been a topic for research for over a decade now. Gutwin, Stark and Greenberg (1995) identify four general types of awareness that a learner should have to support him or her in the team learning process: *social awareness*, *task awareness*, *concept awareness* and *workspace awareness*. While some of these types are possibly more important than others in most settings, *team awareness* is the more general term, being thus a superset of these four types.

Jang, Steinfield and Pfaff (2000) identified four specific types of awareness deficiencies in today's virtual (distributed) teams. Generally speaking, there is a lack of awareness about others' *activities* (what are they doing?); about others' *availability* (when and how to reach them?); about *process* (where are we in the project?); and about the *perspective* (what are the others thinking and why?).

Ferscha (2000) defined a team awareness system as being responsible for facilitating awareness of team activity by communicating work context, agenda and workspace information just-in-time to the user interfaces of relevant team members and granting anytime access to team memory.

2 Team awareness to enhance learning in context

To enable people to learn not just side by side, but together, to form teams and interact with each other, it is crucial to use not only the information about the individual learner's context, but also that on the context of the whole learning team, supporting the members' interaction in those teams.

2.1 What is context?

Many attempts have been made to define the notion of context. Most definitions of context are made by enumeration of examples or by choosing synonyms for context. In the work that first introduces the term 'context-aware', Schilit and Theimer (1994) refer to context as 'location, identities of nearby people and objects, and changes to those objects'. In a similar definition, Brown, Bovey and Chen (1997) define context as 'location, identities of the people around the user, the time of day, season, temperature, etc'. Ryan, Pascoe and Morse (1997) define context as the 'user's location, environment, identity and time'.

A widely used definition is the one given in the PhD thesis of Dey (2000), who says that context is:

any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves.

Following this definition, Dey (2000) defines a system as being context-aware 'if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task'. Other definitions of context-aware systems include 'systems that adapt themselves to context' (Schilit and Theimer 1994) or 'systems having the ability to detect and sense, interpret and respond to aspects of a user's local environment and the computing devices themselves' (Ryan, Pascoe and Morse 1997).

2.2 Context dimensions

In order to design context-aware applications systematically, it is useful to identify categories of context (so-called context dimensions) that help designers to uncover the most likely pieces of context to be used. Although many and various classifications have been proposed, we will present the categories that Dey (2000) identified, as these are the most common ones.

The number of dimensions that could be identified is nearly uncountable, but in practice, some of them are more important than others. These are *location*, *identity*, *activity* and *time*, which could be seen as the primary context types for characterising the situation of an entity, as they can serve as indices into other sources of contextual information (secondary context types). If we know a person's identity, we can easily derive related information (such as birth date, list of friends or e-mail addresses) from several other data sources. Knowing the location of an entity, we can determine the nearby objects and people and what activity is occurring near the entity.

There are some situations in which multiple pieces of primary context are required to index into an information space to acquire secondary context information. For example, the forecasted weather is a context dimension for outdoor activity and can be obtained by querying a forecast database with the desired location and time.

2.3 Mobile learning context

Tailored to mobile learning settings, the notion of context can be defined slightly differently. The learning context as defined by Wang (2004) reads as follows: 'any information that can be used to characterize the situation of learning entities that are considered relevant to the interactions between a learner and an application'.

Wang (2004) identifies six dimensions that are relevant in computer-aided mobile learning:

- identity
- spatio-temporal
- facility
- activity
- learner
- community.

Location has proved to be one of the most important and effective contexts in many applications. Besides identifying the geographical position of the user, it makes sense to introduce some sort of meta-information that enables the system to distinguish between locations used for different purposes. In learning settings, for example, these 'meta-locations' could be classroom, home or outdoors, thus enabling the system to adapt to the current learning situation.

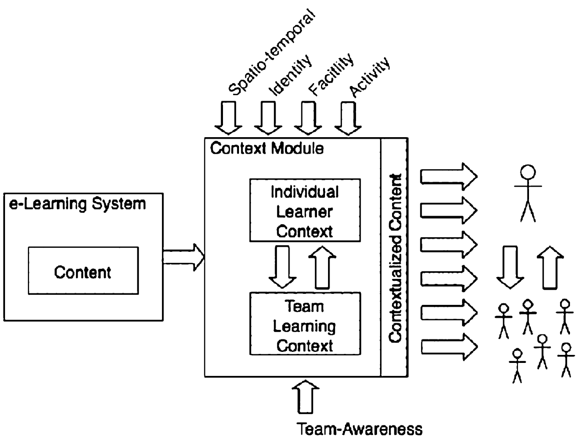
In our approach, we are adding team awareness as a seventh dimension, as the six predefined context dimensions are single-user centred and do not cover issues that can only arise when looking at the learning team as a whole. The context of the team is distilled out of the individual contexts of its members. Therefore, the team awareness dimension might seem to overlap strongly with several of the dimensions defined by Wang, especially the community dimension and the activity dimension. As the context of a team is much more than the sum of the contexts of the team's members, the difference is that team awareness focuses on the team itself and not on the single users, enabling us to gather high-level context information about the team by combining the members' contexts.

For example, it would now be possible to notify the user of a meeting of other team members occurring somewhere else.

2.4 Architectural model

Taking into account all the issues stated above, we could now construct an architectural model (see **Figure 2**), which shows the role of context in a team learning setting. Context is sensed, transformed and represented in the context module. This module holds the individual learners' contexts, but it also generates and holds the team learning context, taking into account team awareness information.

Figure 2
Architectural model showing the role of context in a team learning setting



The context module serves as an interface for the learners, not only adapting content to the current context of the learner, but also providing additional information about the context of the learner and his/her colleagues. A comparable architecture has been developed by Lonsdale *et al.* (2003) as part of the MOBIlearn project (2005). The main difference in our approach is that we explicitly use team awareness as a context dimension, focusing on the team as a central part of (mobile) learning settings.

3 Team awareness and interaction support

With the system presented here, we have developed and implemented an extensible architecture that uses several dimensions of context gathered from individual users to compose team awareness information. This information is presented to the team members and used to support interaction within teams.

For now, only a subset of team awareness is supported. We focus on parts of workspace and social awareness that can be used to enhance the interaction among team members. As the whole architecture is built upon a highly extensible and dynamic framework (Beer *et al.* 2003), however, it is fairly simple to add further context sources, thus extending the aspects of team awareness that are covered.

3.1 Gathering individual context information

The context dimensions that are used in our system at the current stage of development are identity, time, location and activity. Information on time could easily be obtained by querying the RTC (Real Time Clock) of the learner's computer. Much more sophisticated is the detection of the learner's current location. For this purpose, we have developed a technology-independent positioning system, currently using WLAN (wireless local area network), RFID (radio frequency identification) and Bluetooth sensors. As our user interface is built upon an instant messenger that utilises an existing messaging network (namely ICQ), we are using the features of this network to obtain identity and activity information.

3.2 Triggering context-aware services

Once information has been gathered about the context of the learner and his/her co-learners, we can now trigger context-aware actions to acquire team awareness and support team interaction. A context-aware action is one of the following types (Dey 2000):

- context-aware presentation [passive context awareness (Chen and Kotz 2000)]
- automatic execution of services (active context awareness)
- tagging of context for later retrieval.

To realise context-aware actions, we use the SiLiCon Context-Framework, an event-based system, which is described by Beer *et al.* (2003). The open architecture of this framework allows us easily to extend not only the context sources used, but also the behaviour of our application to improve the support for team awareness and interaction.

3.3 Presentation of team awareness information and support of interaction

Using the available pieces of context, we identified several functionalities that are useful for the support of synchronous and asynchronous interaction in teams and the presentation of team awareness information. As already stated, our user interface is based on an existing instant messenger, using the features it already provides.

Synchronous interaction for individuals and groups
While current messaging systems often support only peer-to-peer interaction, it is also necessary to support synchronous group interaction; for example, in cases where team members initially do not know each other (as may be the case in settings where the participants of a lecture form a learning team). For that reason, we have developed team contacts that are displayed in the contact list of the messenger and can be used like standard contacts.

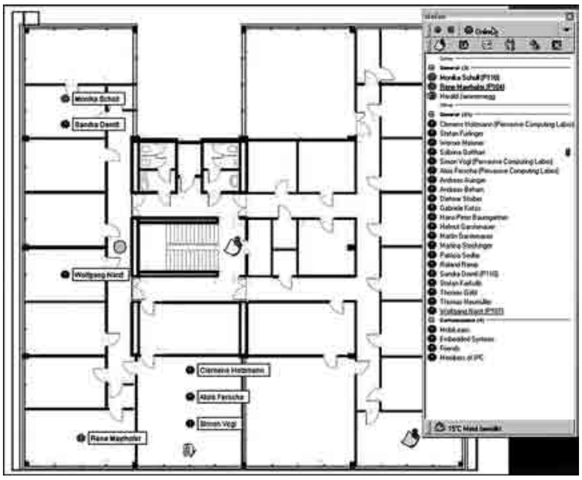
Asynchronous interaction for individuals and groups
While in general, e-mail or forums cover this aspect, we extend the concept of asynchronous interaction by messages ('post-its') being bound to physical locations, thus enabling users to leave messages for others in the context of the current location. These virtual 'post-its' can also have an expiry date, and visibility can be restricted to certain teams. It is also possible to comment on 'post-its'. For example, users could leave a note at their office when they leave, telling others (but maybe only the members of their department) where they can be found. Another possible application is the virtual blackboard, where people could post requests, offers or simply relevant information.

Team formation support
Teams differ in their purpose, so it is necessary to provide different types of team: closed teams (with an owner); open teams, which can be manually joined and left by the users; and dynamic teams, which are formed automatically by the system using the current context of possible members and meta-information about the dynamic team's location (whether it makes sense or not to build a team at the current location).

Team meeting support
Using the available context information, we are trying to recognise team meetings to provide several supporting services. These include registering members joining and leaving the meeting, notifying absent members and supporting protocol storage and distribution among team members.

To support awareness about the activity and location of team members (as a subset of team awareness), we permit automatic availability adoption (depending on user-defined rules using location and time as triggers). We also display the current location of all team members in the contact list and (optionally) in a floor-plan-based graphical viewer. Several more tools to support individual task and awareness management are available, but these are not presented here. **Figure 3** shows the running system with enabled 2-D viewer.

Figure 3
Running system with enabled 2-D viewer



The current version of our system (see **Figure 3**) is, in the autumn of 2005, in its internal evaluation stage. After this evaluation is completed, it will be made available to students at the University of Linz, enabling them to become aware of their friends' and team members' availability and position. This will enable them to extend their interaction possibilities easily without needing to get used to a new interface (as our system is built on an existing instant messenger). This field test will also be a chance for us to evaluate the scalability and user-acceptance of our approach.

4 Summary

We have shown the need for using context information to support learning in teams. It is necessary to make use of both the individual learner's context and team awareness information to make possible content adaptation and context-aware presentation of information as well as context-aware support for interaction in groups.

We believe that it is crucial to build awareness systems upon flexible and extensible frameworks, thus providing a platform that can easily be adapted to the available context sources and to the required form of presentation.

With the implemented system, we show ways of having context-aware interaction support in teams and presenting team awareness information to team members, providing a starting point for a comprehensive team awareness support system.

References

Beer W, Christian V, Ferscha A and Mehrmann L (2003). Modelling context-aware behavior by interpreted ECA rules. In *Proceedings of the International Conference on Parallel and Distributed Computing, Klagenfurt, Austria, 26–29 August*. Austria: Springer Verlag, 1064–1073.

Brown PJ, Bovey JD and Chen X (1997). Context-aware applications: from the laboratory to the marketplace. *IEEE Personal Communications*, 4(5), 58–64.

Chen G and Kotz D (2000). *A survey of context-aware mobile computing research*. Hanover, NH: Computer Science Department, Dartmouth College.

Dey A (2000). *Providing architectural support for building context-aware applications*. PhD thesis: Georgia Institute of Technology.

Dourish P and Bellotti V (1992). Awareness and coordination in shared workspaces. In *Proceedings of the 1992 ACM Conference on Computer-supported Cooperative Work, Toronto*. New York: ACM Press, 107–114.

Ewell PT (1997). *Organizing for learning: a point of entry*. Draft paper prepared for discussion at the 1997 AAHE Summer Academy at Snowbird. National Center for Higher Education Management Systems (NCHEMS). At www.intime.uni.edu/model/learning/learn_summary.html

Ferscha A (2000). Workspace awareness in mobile virtual teams. In *Proceedings of the IEEE 9th International Workshop on Enabling Technologies: Infrastructure for Collaborative Enterprises, Gaithersburg, Maryland, 14–16 March*. IEEE Computer Society Press, 272–277.

Gutwin C, Stark G and Greenberg S (1995). Support for workspace awareness in educational groupware. In *Proceedings of the Conference on Computer Support for Collaborative Learning, Bloomington, Indiana, 17–20 October*. New York: ACM Press, 147–156.

Hull D (1993). *Opening minds, opening doors: the rebirth of American education*. Waco, TX: Center for Occupational Research and Development.

Jang CY, Steinfield C and Pfaff B (2000). Supporting awareness among virtual teams in a web-based collaborative system: the TeamSCOPE System. *SIGGROUP Bulletin*, 21(3), 28–34.

Lonsdale P, Barber C, Sharples M and Arvantis T (2003). A context awareness architecture for facilitating mobile learning. In *Proceedings of MLEARN 2003, London, 19–23 May*.

MOBIlearn (2005). *Website*. At www.mobilearn.org

Ryan N, Pascoe J and Morse D (1997). Enhanced reality fieldwork: the context-aware archaeological assistant. In V Gaffney, M van Leusen and S Exxon (eds) *Computer Applications in Archaeology*.

Schilit B, Adams N and Want R (1994). Context-aware computing applications. In *Proceedings of 1st International Workshop on Mobile Computing Systems and Applications*, 85–90.

Schilit B and Theimer M (1994). Disseminating active map information to mobile hosts. *IEEE Network*, 8(5), 22–32.

Wang Y (2004). Context awareness and adaptation in mobile learning. In *Proceedings of the 2nd IEEE International Workshop on Wireless and Mobile Technologies in Education, Jhongli, Taiwan, 23–25 March*. IEEE CS Press, 154–158.

M-learning: an educational perspective

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Abstract

With the exponential development in technology, there is always the danger that the equilibrium between technology and learning is disturbed. This paper aims to look at m-learning from an educational perspective. The context of this perspective is higher and lifelong education in a developing country.

Keywords
m-learning, e-learning, lifelong learning, adult learning, education, higher education, media attributes

1 Conceptualisation

How would you categorise the learning taking place in the following examples in **Figure 1**? Are we referring to 'flexible', 'distance', 'e-' or 'm-' learning? Shouldn't we refrain from all this 'hype' and focus on the essence – the learning?

Figure 1
Examples of learning situations

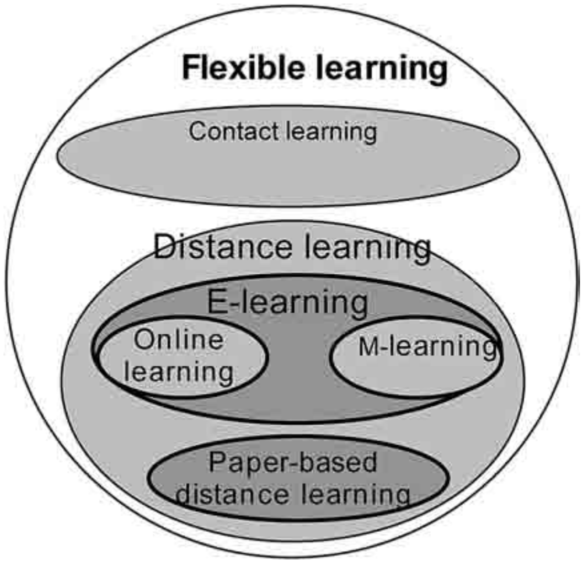
Example 1
Listening to a learning programme on an audio cassette while driving your car

Example 2
Reading study material or a textbook in print, compared to reading a PDF text on your computer, while travelling by train

Example 3
Reading e-mail from your lecturer at home, your office or at a 'hotspot' at the cafeteria

By trying to categorise the examples into the different subsets (see **Figure 2**), you will agree that 'learners … continually on the move…' (Brown 2004) cannot sufficiently serve as a unique descriptor of mobile learning (m-learning).

Figure 2
The subsets of flexible learning



Brown (2004) pictures the relationship between m-learning and the other different subsets quite clearly, as shown in **Figure 2**.

Shepherd's statement (2001) that: 'm-learning is not just electronic, it's mobile', suggests that m-learning is a subset of e-learning (see also Brown 2004). This, unfortunately, does not sufficiently clarify the term 'mobile'. Quin (2001) tries to overcome this problem by providing some examples: 'M-learning is e-learning through mobile computational devices: Palms, Windows CE machines, even your digital cell phone'.

For the purpose of this discussion, I will define m-learning as the use, both synchronously and asynchronously, of mobile communication technology (MCT) to achieve a learning task or outcome.

2 Contextualisation

In order to lay a foundation for further discussions, m-learning is placed in the context of formal higher education (HE) in a developing country.

Mobile communication technology (MCT) will be used differently and for different purposes, based on the different needs of adult learners with regard to formal, informal and non-formal lifelong learning.

The consideration of m-learning as a viable option for the formal HE sector should be based upon factors such as convenience, expediency, immediacy (Seppäla and Alamäki 2003), cultural preferences, access, media literacy and affordability from the learner's perspective.

The *per capita* income, poor infrastructure, preference for oral communication and 'digital divide'[1] in Africa makes 'leapfrogging'[2] with regard to m-learning an attractive proposition.

3 An educational perspective

When discussing m-learning *per se*, it is necessary to distinguish clearly between the use of mobile technology for administrative purposes and its use for the facilitation of learning.

I am of the opinion that most of the instances where MCT is being used in higher education, it is for administrative support of learning, rather than for learning itself. The case study at the University of Pretoria (Brown 2004), where mobile phones are used to support learning at the Faculty of Education, as well as the project at the Faculty of Health Sciences where personal digital assistants (PDAs) are being used to assess medical learners during their Objective Structured Clinical Examination (OSCE) are cases in point.

Apart from administrative uses, learners could also use MCT to contact an expert, a fellow member from a community of practice (COP), or even search a database in order to get just-in-time information. This type of learning usually takes place on a less structured level.

The question is: to what extent can m-learning contribute within the context of structured or formal higher education?

This issue could have been approached from a *constructivist*, *cognitive* or even from a *developmental* perspective on learning – rather than from a technological one.

Instead, the adapted model of Bloom's taxonomy by Anderson and Krathwohl (2001) is taken as a point of departure in order to look at the possibilities of m-learning in higher education by merging the knowledge dimension with the cognitive process.

Although this revised taxonomy (see **Figure 3** below) is focusing on the development of objectives, it could also be applied to the implementation of m-learning in higher education. Understandably, the scope of this paper will not allow a detailed discussion.

From the lecturer's viewpoint, considering the dimension of the knowledge will ensure that the learning task is applicable. Considering the different cognitive processes will ensure a variety in the complexity of learning level. The challenge is to identify attributes (like screen size or storage capability) and select the MCT that is appropriate for the learning task and level. This is, however, still very much a content-based educational paradigm!

From the learner's viewpoint, m-learning should be transparent,[3] based on collaborative learning that is just-in-time (JIT). The nature of this learning is based on new insights arrived at through the 'chunking' of JIT information.

Figure 3 The revised taxonomy table
Adapted from the *Encyclopaedia of Educational Technology* (2004)

The knowledge dimension	**The cognitive process dimension**					
	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual knowledge	☐	☐	☐	☐	☐	☐
Conceptual knowledge	☐	☐	☐	☐	☐	☐
Procedural knowledge	☐	☐	☐	☐	☐	☐

For example, should the learner need to understand procedural knowledge (see **Figure 3** opposite), he or she would hardly use Short Messaging System (SMS), but would rather make a phone call to achieve the learning task.

To conclude, even in a formal learning situation, MCT could be used to achieve different learning tasks at different levels. By shifting the focus from the technology and its promising potential to sound fundamental educational applications, m-learning will be accepted by the broad HE community.

References

Anderson LW and Krathwohl D (eds) (2001). *A taxonomy for learning, teaching, and assessing: a revision of Bloom's Taxonomy of Educational Objectives*. New York: Longman. At: http://coe.sdsu.edu/eet/Articles/bloomrev/index.htm, accessed May 2004.

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

Encyclopaedia of Educational Technology (2004). *Bloom's revised taxonomy*. At: http://coe.sdsu.edu/eet/articles/bloomrev/index.htm, accessed May 2004.

Quin C (2001). *mLearning: mobile, wireless, in-your-pocket learning*. At: http://www.linezine.com/2.1/features/cqmmwiyp.htm, accessed May 2004.

Seppäla P and Alamäki H (2003). Mobile learning in teacher training. *Journal of Computer Assisted Learning*, 19(3), 330–335.

Shepherd C (2001). *M is for maybe*. At www.fastrak-consulting.co.uk/tactix/features/mlearning.htm, accessed 29 March 2004.

Endnotes

1 Digital 'divide' refers on the one hand to those who have the technology and are able to use it; and those on the other hand, who either do not have the technology and/or are not able to use it.

2 Leapfrogging' implies that certain phases in technological development are skipped to catch up with the rest of the world.

3 The learner should hardly notice that s/he is learning.

Mobile vision for ambient learning in urban environments

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Abstract

We describe a mobile vision system that is capable of automated object identification using images captured from a personal digital assistant (PDA) or a camera phone. We present a solution for a technology that will enable outdoors vision-based object recognition, which will extend state-of-the-art location and context aware services towards the achievement of object-based awareness in urban environments. In the proposed application scenario, tourist pedestrians are equipped with a Global Positioning System (GPS), a wireless local area network (WLAN) and a camera attached to a PDA or a camera phone. They are asked to look and see whether their field of vision contains tourist sights that would prompt them to seek more detailed information. A mobile user who is intending to learn within the urban environment might want to explore multimedia-type data about the history, architecture or other related cultural context of historic or artistic relevance. Accordingly, ambient learning is achieved by pointing the device towards the sight, capturing an image and consequently getting on-site information about the object within the focus of attention – that is, the user's current field of vision.

Keywords
mobile vision, object recognition, location-based services, learning in urban environments

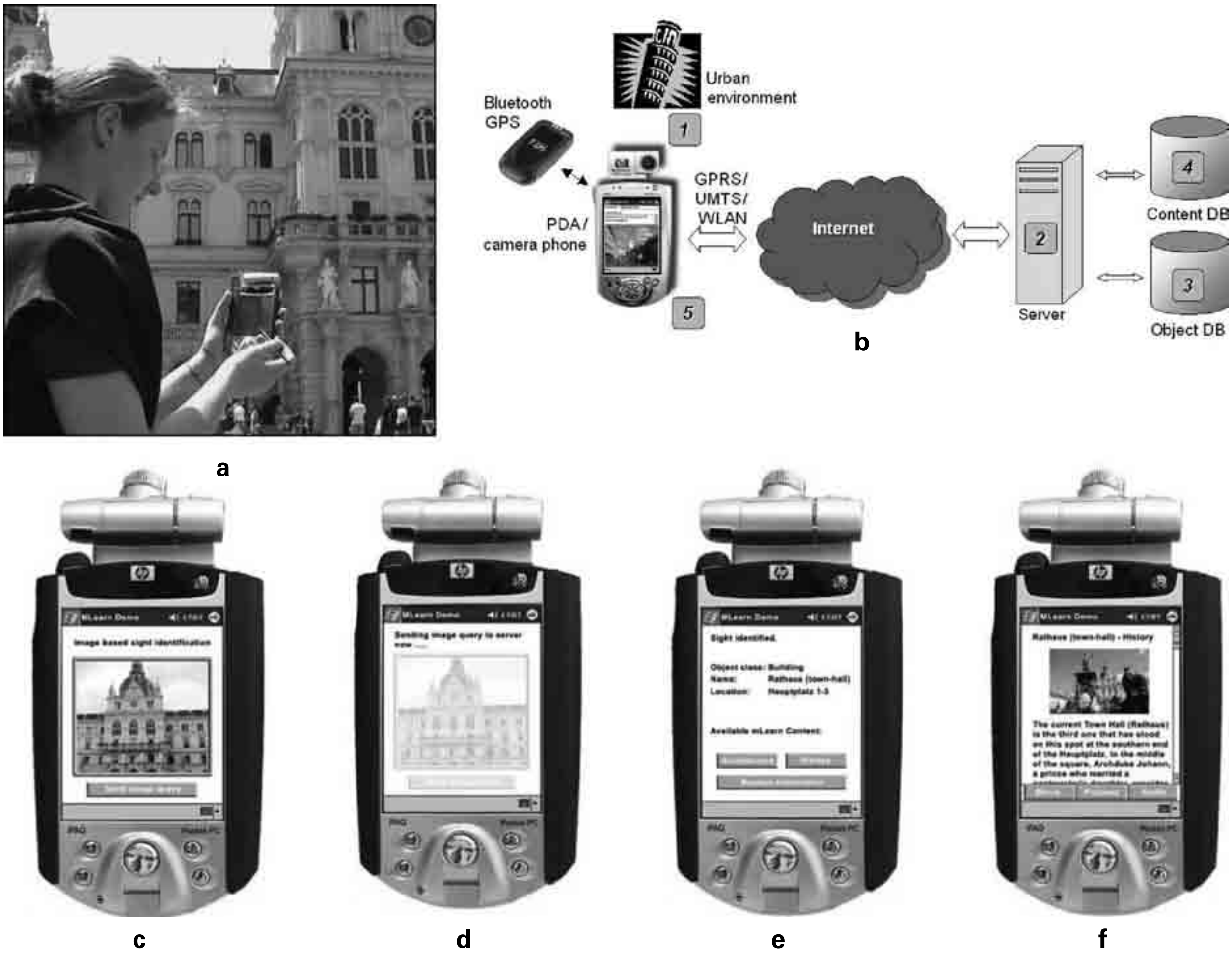
1 Motivation for the project

Mobile learning systems operating in urban environments must take advantage of contexts arising from the spatial and situated information at the pedestrian user's current location. Location-based services today are, in principle, able to provide access to rich sources of information and knowledge to the nomadic user. However, the kind of location awareness that they do provide is not intuitive, requiring reference to maps and addresses – in other words, the information is not directly mediated via the object of interest.

In contrast, the work presented here takes a decisive step towards getting in line with the user's current intention to relate information to his or her current sensorial experience – the object in his/her line of sight (**Figure 1a**). In this way, the system can respond to the user's focus of attention; for example, for the purpose of tourist information systems. A camera attached to the mobile system (PDA or camera phone) pointing towards the object of interest (eg a building or a statue) will capture images on demand, automatically finding objects in the tourist user's view. The images are then transmitted to a server that automatically extracts the object information, associates it to m-learning content and sends the resulting data back to the mobile user (**Figure 1b**). 'Mobile vision' here refers to mobile visual data that is processed in an automated way to provide additional information to the nomadic client in real time.

State-of-the-art pattern recognition in mobile computer vision has advanced from indoors processing (Aoki, Schiele and Pentland 1999) and time-consuming outdoors recognition (Coors, Huch and Kretschmer 2000) to nomadic sign identification (Yang *et al*. 2001) and attentive processing for robust recognition performance (Fritz *et al*. 2004). Layered mobile location-based services (Hightower, Brumitt and Borriello 2002) support, in addition, more accurate estimates about the immediate environment of the user; for example, to provide mobile tourist information services (Almer and Luley 2003). The goal is to annotate detected objects with characteristic data and to provide an interface to access even more detailed multimedia information about the selected object.

Figure 1 The nomadic tourist using a vision-enhanced ambient learning system



1a The nomadic tourist explores the city in interaction with his/her vision-enhanced ambient learning system.

1b The image capture relating to the tourist sight is transmitted via the internet to the server that performs image processing and automated object recognition.

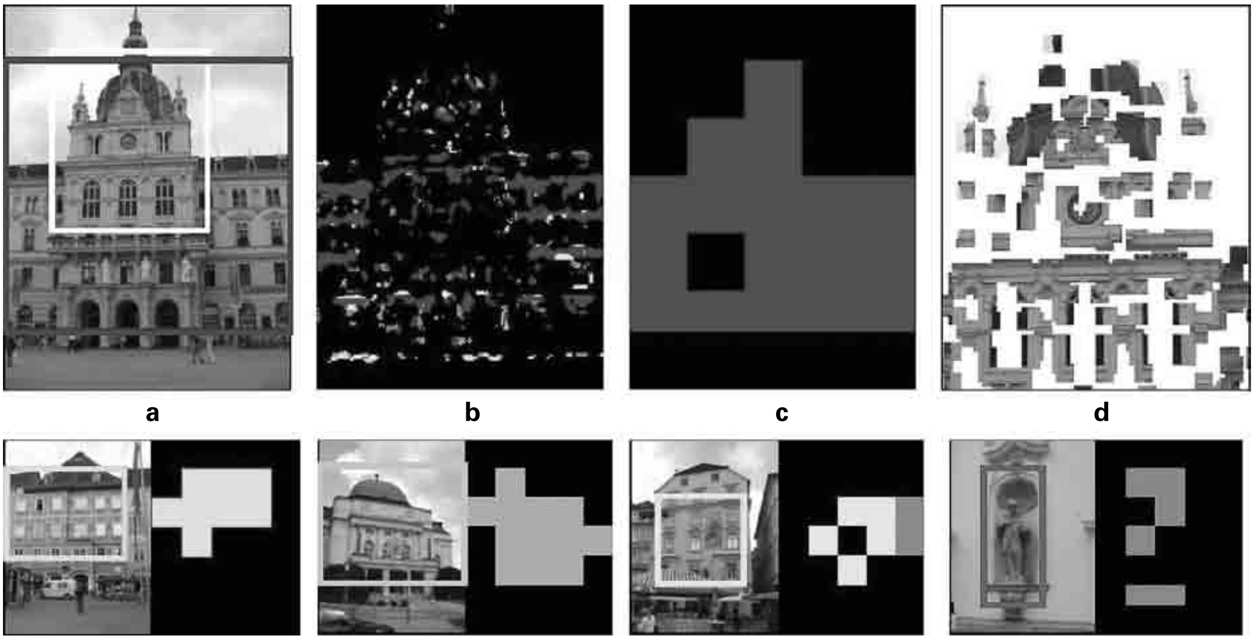
1c–f Screenshots from the mobile learning system: (**c**) the user initiates sight identification via an image query; (**d**) the image is transmitted to the server; (**e**) the resulting information is displayed at the client site; (**f**) contextual information is provided together with a menu that links to additional information sources (movies, pictures, audio, etc).

Entries within a corresponding database of multimedia information of various kinds (images, video, sound, texts) are interlinked to enable cross-referencing and access to different information spaces (**Figure 1c–f**).

2 Mobile learning using visual object detection

The user equipment of the ambient learning system (**Figure 1b**) consists of a camera-based PDA or camera phone and a GPS receiver connected via Bluetooth. The client device should provide an integrated or connected camera with a resolution of at least 640x480 pixels as supported by the industrial standard today. The mobile device is linked via wireless connection to a server. We assume that, at the very least, a mobile phone network can be used to establish an internet connection;

Figure 2 Operation of the mobile vision system



a b c d
e f g h

2a The mobile vision system operates on grey-level pixel patterns; for example, with reference to the Town Hall in Graz.

2b It first identifies distinctive local patterns (Fritz *et al.* 2004) in the complete image (**d** depicts the corresponding local patterns from the region in **a**, circumscribed by the white rectangle). Blue pixels were classified as 'voting for' the 'town hall object'.

2c describes a tiled image partition, being colour coded from a more abstract voting process.

2e–h Colour coding of correct object classifications for several sights and a statue (**h**) found among the sights of interest to tourists in Graz.

alternatively, different data transfer technologies like General Packet Radio Service (GPRS), Universal Mobile Telecommunications System (UMTS) or wireless local area network (WLAN) could be used as well, depending on the choice of local network providers. Object identification is performed at the server site and hidden to the user who just receives the result (**Figure 1e**) in about 2–3 seconds. The server receives a raw GPS-based position estimate and collects a selection of relevant sights which potentially might appear in the tourist's field of vision. The user initiates an image capture to start the visual object recognition (**Figure 2**). The system first extracts a grey-level pixel pattern (**Figure 2a**) and identifies image regions that are highly discriminating with respect to object identification (**Figure 2b**). Larger regions of local object votes (**Figure 2c**) are integrated in a second processing stage, resulting in a single object vote (eg the blue rectangle in **Figure 2a**).

The demonstration system contains 10 local objects of interest from the city centre of Graz in Austria (buildings, statues, etc; see sample results in **Figure 2e–h**), but is currently being extended to display up to 50 objects of interest to tourists. The PDA will then display associated m-learning information from the content database corresponding to the object-search result (**Figure 1b and f**). The multimedia information will describe the cultural context relating to the object in the field of vision, enabling the user to learn within the urban environment. The presented experimental results seem to be promising and are being extended to evaluate larger object sets.

References

Almer A and Luley P (2003). Location-based tourism information on mobile systems. In *Proceedings of the European Navigation Conference, Graz, Austria, 22–25 April*.

Aoki H, Schiele B and Pentland A (1999). Real-time personal positioning system for wearable computers. In *Proceedings of the IEEE International Symposium on Wearable Computing, San Francisco, California*. Los Alamitos, CA: IEEE Computer Society, 37.

Coors V, Huch T and Kretschmer U (2000). Matching buildings: pose estimation in an urban environment. In *Proceedings of the IEEE and ACM International Symposium on Augmented Reality, Munich, 5–6 October*, 89–92.

Fritz G, Seifert C, Paletta L and Bischof H (2004). Rapid object recognition from discriminative regions of interest. In *Proceedings of the National Conference on Artificial Intelligence, San Jose, California*.

Hightower J, Brumitt B and Borriello G (2002). The location stack: a layered model for location in ubiquitous computing. In *Proceedings of the IEEE Workshop on Mobile Computing Systems and Applications, Callicoon, New York*. Los Alamitos, CA: IEEE Computer Society, 22–28.

Yang J, Gao J, Zhang Y and Chen X (2001). An automatic sign recognition and translation system. In *Proceedings of the Workshop on Perceptive User Interfaces, Lake Buena Vista, Florida, 15–16 November*.

Mobile learning in tomorrow's education for MBA students

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Abstract

This paper reports on the MBA case-study scenario strand of the MOBIlearn project, focusing on the user trials and evaluations planned for the autumn and winter of 2004. It specifies the added value expected by integrating the MOBIlearn system into a traditional MBA-course lecture. This paper tries to indicate what kind of results might be gained from the user trials and the evaluation of the MOBIlearn system.

All results presented in the framework of the MOBIlearn project are funded by the Swiss Federal Office for Education and Science (BBW).

Keywords
mobile cooperative learning, case-study education

1 Introduction

MOBIlearn is about to start the final phase of evaluating the MOBIlearn system with real users. The MOBIlearn system has been developed during the past 2 years based on three main scenarios: museums, health and MBA study. More details about the scenario-driven approach and its impact on system design are presented in Evans and Taylor (2005). The present paper reports on the MBA scenario, which is led by the University of Zurich, with regard to the evaluation planned for the autumn and winter of 2004. To put the discussion into context, section 2 describes the profile of a typical Zurich MBA class which is significantly different to that of a class of undergraduates. Section 3 reports on the expected added value of mobile technology and on evaluation plans based on three selected relevant challenges derived from a formal MBA-course lecture. Section 4 addresses evaluation issues when doing a case study during an MBA course.

2 User profile of Zurich's MBA students

Typical Zurich MBA students are between 35 and 45 years old and already have a couple of years of practical management experience. They are used to working under extreme time pressure and must coordinate their participation in the MBA course with their daily business. Often they do not work in their office, but have meetings outside and thus need to be very mobile. They are experts in their specific area of business, and within this area, they have practical knowledge that is superior to that of fellow students and even the lecturer. They expect to get some high-level theoretical reflection in their area of excellence plus up-to-date knowledge about other areas that are relevant to their job or career. So an MBA class of about 40 students is an extremely heterogeneous and demanding group, with both experts and lay members in any topic coming from very different sectors, companies and departments. The MOBIlearn scenario for such an MBA course contains two elements: a traditional lecture (see section 2); and a case-study exercise to be solved in small groups (see section 3).

3 The added value of mobile technology in a traditional MBA-course lecture

There are some requirements for integrating mobile technology into a traditional course lecture: each student needs to be equipped with a mobile device, such as a personal digital assistant (PDA), which has a set of mobile learning tools installed and allows wireless local area network (WLAN) access. The classroom needs WLAN coverage and an additional electronic blackboard or beamer. Furthermore, the lecturer needs central tools and functionalities in order to moderate and control the class activities. An assistant should support him or her in moderating and dealing with the digital channel.

There are several challenges to be faced when teaching an MBA course. This section addresses three specific challenges that lead into several research questions concerning what value can be added when using mobile technology.

First, the teacher needs to present the content in accordance with the previous knowledge of the class. Students with no or little previous knowledge should not be swamped; and students with expert knowledge should not get bored by the lesson. The teacher usually does not know the MBA students' previous knowledge in detail, which complicates the situation and may lead him or her simply to ignore the heterogeneity of the class. One way to ensure some minimum previous knowledge would be to ask the students to prepare for the lecture individually in advance. However, a flexible teacher could try to get a constant feedback about the class performance and adopt his or her lesson to the current needs of the students.

Addressing this challenge would be easy with a very simple tool that provides just three buttons: red, yellow and green, plus a comments box on each client. Students could indicate to the teacher whether they currently feel comfortable with the lecture or not. As long as 'green' is pressed, there are no problems, but 'yellow' or even 'red' means that either the student cannot follow any more or conversely, feels unchallenged. The text box can be used to specify the problem. It is up to the teacher either to show the overview from the server publicly or just keep it private on a separate screen for him/herself. If there appear to be too many red or yellow indications, the teacher gets a clear message to deal with it in a proactive way. Using class awareness tools of this kind, the lecturer would be able to deal sensitively with the needs of the class.

A tool of this sort will not be part of the integrated MOBIlearn system, but is currently being developed in Zurich to be used during the final user trials of MOBIlearn. The questions to consider are first, whether students and teachers accept and use the tool; and second, if it makes a positive difference to the teacher's performance. Both questions will be addressed in questionnaires and in interviews.

Second, the expert knowledge of the audience is often not exploited, because possibilities to share it at the right moment are very limited. During observations made in MBA classes (see section 3), students often seemed to be willing to share their experience by telling anecdotes linked to the current content of the lesson. Due to a tough time schedule, however, the teachers cannot allow all the students to tell their story, even though it would be very valuable from a motivational and didactical point of view.

Providing the students with a chat facility or forum so they can share their valuable opinions, questions and anecdotes with the others addresses this challenge. An advanced tool would allow any entry to be linked to the relevant slide of the lecture and thus associate it with the relevant context. The typing of a whole anecdote on a PDA, however, entails a lot of distraction for the writer. A notebook might be a better device to provide this service, but some level of distraction will remain. We assume that most writers will be experts in the area presented by the lecturer, so instead of being bored, they may contribute personal and practical experience to the course community.

There are a number of earlier projects that have already developed and tested useful tools for such activities, but with undergraduate students; for example, ActiveClass, WILD@Mannheim or ConcertStudeo (Lehner, Nösekabel and Bremen 2003). The MOBIlearn system is going to integrate similar tools to support the MBA case-study scenario. The evaluation should give some indication whether the heterogeneity of students and the presence of expert knowledge in an MBA class will lead to different and more positive effects than in a class of undergraduates. The quality (and quantity) of comments made will probably answer this question to some extent.

Third, there is little or no electronic support in a standard classroom for carrying out some effective collaborative group sessions (CSCL – computer-supported cooperative learning); for example, a digital brainstorming session with ongoing prioritisation, categorisation and decision-making support (voting). Such a moderated digital session has been proved to be very effective compared to traditional methods with pencil and paper (Schwabe 1995). It is a valuable way of activating the students, making them think and talk about their thoughts, discuss complex questions and share their knowledge. One possible reference tool for Fixnet applications is GroupSystems (2005). Unfortunately, such tools are not heavily used in everyday teaching practice, because the effort to be spent in preparation outweighs the gain. One reason would certainly be the inconvenience of booking and preparing a computerised room and moving the whole class into it. Flexible and spontaneous use of such methods is simply not possible under those circumstances. With mobile technology, however, the classroom is potentially computerised for free, because students bring their own devices. The evaluation of the MOBIlearn system, which is supposed to support digital group work, should show if the teacher and (MBA) students are more likely to use collaborative group session software when this is available quickly and on demand, making use of mobile technology.

4 The added value of mobile technology in a case-study exercise

The second part of the MBA course scenario in MOBIlearn is the performance of a case-study exercise. Non-technical pre-tests with an MBA class and a class of undergraduates have been done in the winter of 2003/04 and in spring 2004. The MBA course, in particular, with 43 participants, has been evaluated in respect of the MOBIlearn user tests by carrying out observations and a series of interviews which have included nearly all learning groups.

The technical setting would be similar to that described above (section 3), but extended. Additionally, there should be a number of awareness tools to submit the current location of group members or data on their social presence (current availability, willingness to communicate, current activity, etc) There should be WLAN coverage at the university campus, in most companies, and in some cases, at home as well. A number of effects are anticipated and the plan is to evaluate these when integrating mobile technology in order to complete an explorative case-study exercise in group work (collocated, distributed, synchronous and asynchronous). Four of those anticipated effects will be discussed here.

4.1 Mobile technology improves coordination and leads to a shift from asynchronous to more synchronous cooperation which results in a better learning performance

During the observed course, Zurich's MBA students started their group work with a kick-off meeting where they were agreeing on a rough process by which to complete the case-study exercise. About half of the groups of MBA students needed, for business reasons, to work on the case study in a distributed and asynchronous way. They usually split the exercise work into evenly sized sub-tasks, on which each group member worked individually. This approach seems to be most efficient for them, but didactically it is sub-optimal.
By splitting up the work, they miss out on discussing their ideas, do not get a shared understanding of their work and can hardly contribute to each other's work. By integrating mobile technology, the available information about social presence and communication tools allows group members to coordinate their work in a much more flexible and spontaneous way. They can quickly make even small decisions about the work process as needed, avail themselves of the opportunity of meeting by chance, and have the possibility of observing and contributing to each other's work. Thus the cooperation may become closer and more synchronous and overcome the aforementioned barriers.

4.2 Mobile technology supports the build-up of a community network that may last longer than the MBA course

Not only working and learning together, but also sharing private issues might be important to build up lasting friendships and a working community network. The more opportunities there are to have informal conversation, the more likely it is that a community might work. Awareness of the location and social presence of others provided by mobile technology may often serve as a motive to start informal conversations by chance or to ask for help. The evaluation of the MOBIlearn system should show if the frequency of communication increases, and if people feel that these new methods would improve the social network among the MBA students.

4.3 Mobile technology enables case-study exercises which might be integrated into everyday business

Due to their small size and light weight, mobile devices can always be carried with one. Thus, it is always possible to get spontaneous access to a workspace with all data, documents, tools or people. We assume there are spontaneous opportunities during everyday business life where it would be possible to link them in some way to an ongoing case-study exercise – perhaps it would be the sudden chance to interview a key person met at the lunch table; or perhaps an unexpected incident that could be used as an exemplary anecdote from practice; or perhaps simply an idea triggered in the mind by some event. Mobile technology provides ways to keep the current context so that others can understand the situation (using integrated camera; voice recording; saving the information on current awareness status such as location, time or people around) and make immediate notes that can be used as a reminder and notification for other group members.

4.4 Mobile technology helps to reduce the cognitive load of MBA students

MBA students are managers and usually have a very high cognitive load. They have only a very limited capacity to keep details and issues of little importance in their mind long enough for them to be handled. Mobile technology provides them with an opportunity to deal with more of these tasks when they are not in their office, as long as they can be done online right away. Sending an e-mail or message or reaching the right and available partners quickly to make decisions, helps them to tick things off the list as soon as they appear (Straub and Karahanna 1998).

5 Test and evaluation plans for MOBIlearn's final user tests in Zurich

As presented in this paper, there are many facets of mobile learning that will be covered in the user tests. The success of all evaluation plans and activities will depend strongly on the performance of the MOBIlearn system which will be available at the beginning of September 2004. In order to ensure a high-quality system and to allow untroubled user tests, MOBIlearn partners will run a series of technical functional tests and pre-tests to check its usefulness. According to the MOBIlearn project schedule, the user tests will basically be done with undergraduate students until December 2004. If those tests are successful and indicate some added value as expected, further user tests with MBA students can be done in spring 2005.

References

Evans D and Taylor J (2005). *The role of user scenarios as the central piece of the development jigsaw puzzle*. In J Attewell and C Savill-Smith (eds) *Learning anytime anywhere – a book of papers*. Proceedings of the MLEARN 2004 Conference, Rome, 5–6 July. London: Learning and Skills Development Agency.

GroupSystems (2005). Website. At www.groupsupport.com

Lehner F, Nösekabel H and Bremen G (2003). *M-learning und M-education – Mobile und drahtlose Anwendungen im Unterricht*. Regensburg: University of Regensburg.

Schwabe G (1995). *Objekte der Gruppenarbeit – ein Konzept für das Computer Aided Team*. Wiesbaden: Gabler.

Straub D and Karahanna E (1998). Knowledge worker communications and recipient availability: toward a task closure explanation of media choice. *Organization Science*, 9(2), 160–175.

Learning and collaborating using mobile devices and sessions

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Abstract

This paper presents an overview of our latest work on developing a ubiquitous computing framework to allow seamless access to applications from multiple devices. This paper introduces our application session teleportation (AST) framework, designed to support the movement of application sessions between devices in personal area networks (PANs) and across the internet. So far, we have used the AST framework to allow web sessions to be shared between Internet Explorer clients. In terms of mobile learning, this raises further implications for users who are collaborating through shared web sessions from different devices. We present the results from our research into design metrics for content to be used in this type of co-browsing environment.

Keywords
mobile learning, sessions, collaboration, device characterisation

1 Introduction

Within a ubiquitous computing environment, a user will own and make use of many devices that vary in functionality and power. Furthermore, these devices will most likely be interconnected to form a personal area network (PAN). PANs are generally confined to a user's personal operating space, which has a typical range of 10m, but may be extended to 100m for environments such as the home (Braley, Gifford and Heile 2000). Devices may autonomously join and leave the PAN through device detection and location management techniques in an *ad hoc* or seamless manner. For example, a user's home PAN may automatically detect and add a personal digital assistant (PDA) device, which could then be used to interact with other devices within the PAN.

In general, learning applications should support access to meaningful content, provide a means to undertake constructive activities, and allow dialogue and collaboration between learners (see eg Fowler and Mayes 1999). Mobile learning technology adds further opportunities for users to access content from different devices, for moving sessions between devices and for supporting collaborative activities – all potentially from different types of device. This paper focuses on research addressing the technology requirements for mobile learning, and presents early results from research on how we can adapt learning materials so that they are suitable for collaboration and co-browsing from different types of device.

2 Application session teleportation

Application session teleportation (AST) is our candidate framework for supporting session movement in PANs and the internet. PANs may comprise various types of device with a range of computation/storage capabilities. For this reason, some PAN devices such as mobile phones, digital badges and speakers may rely on more powerful devices to teleport application sessions. This has subsequently led us to identify a number of classes of device and modes of interaction – namely, controller, listener, minimal and output nodes.

Figure 1
Controller node architecture

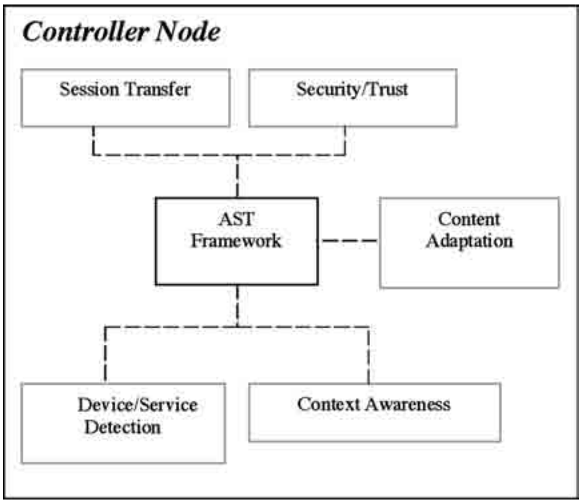


Figure 1 depicts the controller node architecture. Listener nodes will be constructed from a subset of these components (such as session transfer, security and content adaptation). Minimal nodes are essentially thin clients, with lightweight components for session transfer and security, which interact with controller nodes to transfer a session. Finally, output nodes may only process output streams instantiated from controller and listener nodes. Profiling functions are contained in the Context Awareness component and will be required to hold information regarding users, PAN devices, AST applications and their current locations.

Currently, we have built an initial prototype of the AST framework by implementing the Session Transfer and Device/Service Detection components. To implement our framework, Internet Explorer has been adapted to work with AST. This TeleWeb concept demonstrator supports web session teleportation within PANs.

3 Session adaptation

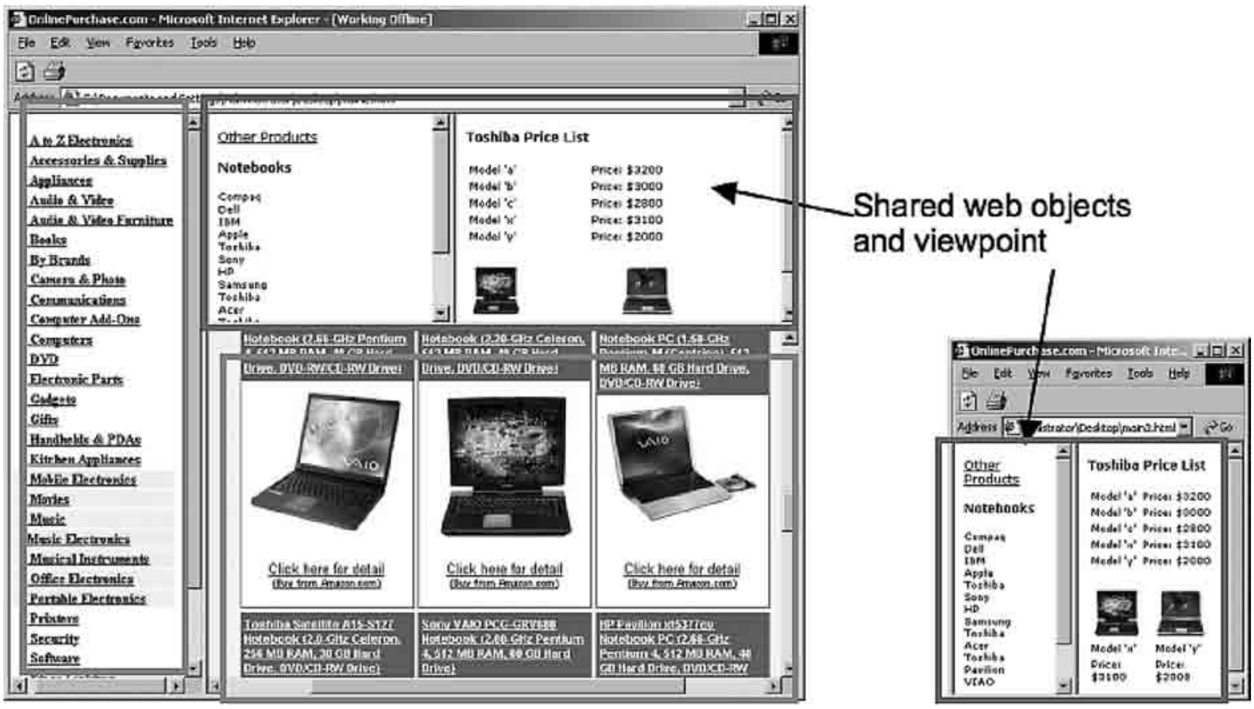
We are also separately carrying out research into the AST Content Adaptation component (see Hoh, Gillies and Gardner 2003). Generally, a limiting factor of mobile devices is their small screen size and limited processing/storage capabilities. Application teleportation may involve two or more PAN devices with differing capabilities. Therefore it will be important to adapt sessions to the characteristics of each particular device.

Recently, much work has been undertaken elsewhere to adapt screen content for display purposes (see Esenther 2002). For example, many applications adapt web pages to comply with bandwidth, screen size and computational restrictions. Traditional content adaptation for small devices has involved using techniques such as discarding irrelevant formatting information. However, novel approaches (eg Fox *et al*. 1998) are aiming to extend the usability of existing web content for small devices.

4 Collaborating from different devices

Once users can access applications from any device, we can then consider scenarios that involve users collaborating by means of these applications on shared learning tasks. However, if they are accessing the application from different devices with different display characteristics, then they may well have completely different views of the same shared information. It may not be possible to view the contents of all these web objects on screen at the same time, especially with smaller device display screens that can only display a limited set of web objects. The main objective of our research is to adapt the relevant information based on the perceived 'utility' of the web objects and the capabilities of the devices being used. The determination of 'utility' could be an automatic or a manual process. We are currently considering a manual method whereby users pre-select the utility of the web objects. **Figure 2** (opposite) illustrates a scenario with two users collaborating from different devices.

Figure 2 Shared viewpoints



5 Design guidelines for co-browsing

Given this scenario, how can we adapt learning materials so that they are suitable for collaboration and co-browsing (see Chua *et al*. 2004) from different types of device? We are currently carrying out research to investigate whether the design metrics of web pages that are perceived as being ‘good’ for single-user browsing are the same as the design metrics for pages that are perceived as being ‘good’ for co-browsing. One reason for believing that the design metrics might differ is that co-browsing requires the users not only to search through the content for relevant material, but also to describe that material and their interactions with it to their fellow users with whom they are co-browsing. If the metrics of ‘good’ pages do differ, then web-page content adaptation schemes implemented in co-browsers will need to alter further the composition and formatting of the contents within the page, to take into account the task at hand as well as the capabilities of the devices being used.

Analysis of our preliminary results indicates that there are only a few differences between what constitutes ‘good’ and ‘bad’ web pages for browsing and co-browsing tasks. However, the results do indicate that the gap between ‘good’ and ‘bad’ pages in co-browsing is more pronounced, which suggests that accounting for task metrics in the adaptation of web pages will be important.

6 Summary

This paper has presented an overview of a number of research activities based around our AST framework and focused on the issues of application session teleportation, session adaptation, heterogeneous device collaboration and design metrics for co-browsing. We have used the AST framework as the basis for a number of research experiments. So far, the experimentation we have done on co-browsing suggests that adapting web-page content for the co-browsing task is best done by emphasising more text and adding large graphics. While it would be very difficult to insert suitable graphics as useful visual cues within a web page, the adding of emphasis to text headers and keywords in web pages is a real possibility for inclusion within automatic content adaptation systems. In the future, this may have a direct impact on the design and development of content for mobile learning services.

References

Braley R, Gifford I and Heile R (2000). Wireless personal area networks: an overview of the IEEE P802.15 working group. *ACM SIGMOBILE Mobile Computing and Communications Review*, 4(1), 26–33.

Chua HN, Scott SD, Tham VK, Gardner M and Blanfield P (2004). *Design metrics for co-browsing*. Paper presented to the 7th International Conference on Work with Computing Systems, Kuala Lumpur, 29 June–2 July.

Esenther AW (2002). Instant co-browsing: lightweight real-time collaborative web browsing. In *Proceedings of the Eleventh International World Wide Web Conference, Honolulu, 7–11 May*.

Fowler CJH and Mayes JT (1999). Learning relationships from theory to design. *Association for Learning Technology Journal*, 7(3), 6–16.

Fox A, Gribble SD, Chawathe Y and Brewer EA (1998). Adapting to network and client variation using active proxies: lessons and perspectives. *IEEE Personal Communications*, 5(4), 10–19.

Hoh S, Gillies S and Gardner M (2003). Device personalisation – where content meets device. *BT Technology Journal*, 21(1).

From virtual cooperation to distance learning: realising remote multimedia platforms on a QoS-enabled network

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Abstract

Exploiting the capabilities of an increasingly powerful and ubiquitous network is the key enabling factor in introducing new collaboration and learning paradigms, where participants do not need to be physically located in the same place. Even more important, in the context of the research and university world, this model permits the sharing of costly equipment between geographically distant laboratories, as well as providing students in remote locations with access to concrete scientific instruments.

While most of the network issues, such as quality of service (QoS), mobility and security are gradually being solved, an adequate set of application-level technologies must be put in place to allow for this model to be deployed.

Keywords
MPEG–4, distance learning, IP QoS

1 Introduction

This paper presents the activities and experiments carried out by the authors in the context of several European and Italian research projects, which initially aimed at providing a technological platform for accessing cultural heritage information through advanced and interactive multimedia systems. As a natural extension of this platform, instruments for providing an enhanced learning experience have been developed, which add support for external, media-synchronised *learning objects*.

The context of such activities is a real-world scenario where the teacher, the support material, the application service provider and the students need not necessarily be co-located, either in space or in time. This approach opens up a scenario where didactic material is not limited to written text or slides, becoming a true multimedia and hypertextual collection of objects supporting the teacher in transferring knowledge to his or her audience.

Embracing the most recent networking technologies and architectural models enables students to attend their lessons from a remote location (be it their home, a remote classroom or conference centre), extending the reach of the platform to telecommuting students, workers and older people; and overcoming the constraints of time and place imposed by the traditional face-to-face training methods.

2 MPEG–4 and the e-learning media platform

The International Organization for Standardization/International Electrotechnical Commission (ISO/IEC) MPEG–4 standard (ISO/IEC Standards Committee 2001) is a comprehensive set of specifications relating to the encoded representation of *audio/visual contents*. The outstanding improvement provided by MPEG–4 over its predecessors (MPEG–1 and MPEG–2), besides the availability of better optimised encoding algorithms and tools, lies in a new approach to contents description: media is not just a video frame and an associated audio track, but rather a complex scene composed of several *audio-video objects* (AVOs) which are assembled together with precise spatial-temporal relationships. Video objects can be just plain old rectangular frames, but they may also be shaped objects which are 'composed' to form the final view. Both natural (ie coming from a camera or a microphone) and synthetic (ie 3-D models and parametric descriptions) AVOs can be freely intermixed in an MPEG–4 scene; furthermore, they can be made 'interactive' by associating commands and actions with them. Finally, AVOs can be associated with *quality of service* (QoS) descriptors and transported through the network over distinct channels (each, potentially, having a tailored QoS profile).

This broad set of tools makes MPEG–4 the ideal choice for implementing a technological platform which is able to deliver enhanced contents for an innovative user experience. The components of the e-learning media platform endowed with MPEG–4 functionalities are the media production and delivery chain (authoring tools, media server and client) and the so-called QoS provision layer. The *production chain* includes some basic tools for the creation of content in the format specified by the standard (MP4 file format) and for its segmentation into tracks suitable for delivery via the network. The *delivery chain* comprises the media server and client, both of which are able to handle MPEG–4 AVOs and scene descriptions.

The QoS *provision layer* is an implementation of MPEG–4 DMIF (Delivery Multimedia Integration Framework), a media-unaware and network-aware signalling protocol allowing the set-up of individual channels and their association with AVOs. The signalling messages also carry information on the QoS requirements for each AVO.

3 Extensions for distance learning applications

This e-learning platform, initially designed to target the delivery of enhanced media in a cultural heritage context, has proved to be suitable also as the basic building block of a *distance learning* system. The ability to intermix synthetic and natural AVOs and to deliver them with QoS guarantees has provided a good starting point for experimenting with distance-based training courses.

The need to have a virtual whiteboard application has been easily satisfied by making the teacher's free-hand drawing application (Microsoft Windows Journal running on a Tablet PC) work remotely. The particular nature of the distance learning scenario requires full synchronisation between the audio/video streams and the whiteboard data stream, as well as the ability to transmit the latter using the same network channels and paradigms (unicast/multicast/broadcast). Hence, a custom application has been developed, whose purpose is to capture periodic screenshots of the selected application and to feed them to the video encoder as synthetic objects. The media server then delivers the 'whiteboard video stream' alongside the teacher's voice and video streams. As expected, the image quality obtained with this approach is quite high, since no intermediate digital–analog–digital conversion takes place between the whiteboard and the end-user screen.

More ambitious applications of the technology reveal the need for more sophisticated functionalities to be built into the platform. Unfortunately, due to limitations both in the standard and in the current implementation, the introduction of such functionalities has implied a slight detour from the MPEG–4 specifications.

Pursuing a more generalised approach, the traditional audio/video stream is augmented with synchronous external objects which, according to the context and adhering to literature usage, have been called *learning objects*. This generic term designates, in the context of our research, any kind of additional material that can be used by the teacher to provide the students with an enriched learning experience. More specifically, the implemented mechanism embeds proprietary *triggers* into the media streams, which bring to the client a specific 'message' along with a timestamp. The message is currently a URI (*Uniform Resource Identifier*) pointing to the remote learning object or a parameter to be passed to the player.

As simple as this mechanism is, it actually allows some interesting functionalities to be realised. The simplest example is the transmission of slides synchronised with audio/video frames: presentation of each slide is activated by triggers which are inserted automatically whenever the distantly located teacher advances his/her presentation. Since triggers are saved together with the media stream when archiving a live presentation for later utilisation, this mechanism also provides for a complete reproduction of the live lesson.

More generally, a wide range of synchronised events on the remote user's side are enabled. More complex examples include 'active' objects (eg simulations and virtual instrument panels) to be downloaded to the client and synchronised with the presentation by using the triggers as clock references and input signals. Support for mobile, platform-independent code (like Java applets or .NET code) is currently being investigated.

4 Network and mobility issues

4.1 Tackling the QoS issues

The well-known '*best-effort*' behaviour of current IP networks is a significant hindrance to the wide deployment of enriched real-time multimedia platforms, whose demanding QoS requirements cannot be met without an adequate provisioning architecture.

The implementation of the experimental network infrastructure has been derived from the architecture envisioned by the Internet Engineering Task Force (IETF) in several Requests for Comment (RFCs) (Blake *et al*. 1998; Durham *et al*. 2000; Bernet *et al*. 2002; and related RFCs 2205, 2474, 2597, 2598, 2749, 3140). This is based on the integrated services approach in the periphery of the network and on the differentiated services approach in the core. This network infrastructure fulfils the needs of applications that are demanding in terms of QoS by being able to differentiate between traffic flows, provide the applications with strict bandwidth and delay guarantees and efficiently manage dynamic resources allocation.

The integration between the application platform and the network is granted by the interface between the QoS provision layer (DMIF) and the network's border routers.

4.2 Mobility and making e-learning applications work remotely

Learners want their content to be as mobile as they are. At the same time, the power of personal digital assistants (PDAs) and other mobile devices is increasing to the extent that this desire can now be fulfilled: learning materials and multimedia contents can efficiently be made accessible to people who are on planes, or other forms of transport, or just in the office. The possibility of mobile utilisation of e-learning services is definitely one of the areas where the most important innovations are expected.

Integration between IP networks – internet, corporate local area networks (LANs) and virtual private networks (VPNs) – and next-generation mobile phone infrastructures [eg 3rd Generation Partnership Project (3GPP)] is the major challenge that must be faced from this point of view. Also, interworking with satellite networks is the ideal way to support provision of services in rural and mountain areas, thus reducing the 'digital divide' and providing innovative ways of teaching people in remote regions.

Early experiments with the e-learning platform have been performed by making lessons taught from the University of Pisa available remotely to students located in a suitably equipped classroom in the nearby town of Lucca, over a 34 Mbps radio link. **Figure 1** (overleaf) illustrates the virtual classroom environment. External facilities, which have been introduced into the platform to make it more usable, include a content management system (for lesson planning and students' subscription) and an H.323 Voice-over-IP (VoIP) service platform (to provide real-time interaction between the remotely located students and the teacher). The same lessons have been made available to students attending from their home and accessing the network over 320/128 Kbps ADSL links.

The e-learning platform is also being made accessible from within the Alcatel Multimedia Communication Centre (MMC: see **Figure 2** overleaf) in Vimercate in Italy, as part of a technology programme whose main objectives are to extend available e-learning platforms and to realise a distributed testbed interconnecting several 'islands' (isolated testbeds) including Pisa, Rome, Naples and Vimercate. The testbed, which also includes the Alcatel 3G Reality Centre for mobile demonstrations and integration with 3rd-generation Universal Mobile Telecommunications System (UMTS) mobile phones, is currently used for experimentation and development.

5 Conclusions

The technologies required for the realisation of enhanced e-learning and distance learning platforms are definitely mature enough to start thinking about real-world commercial deployment. The synergy of hardware capabilities, network infrastructure and multimedia applications cannot be exploited without a convergent approach, combining these complementary aspects in a unique architectural view.

Dealing with established working methodologies while proposing innovative services to the end users, who here include both the teachers and the students, is another critical issue. The most promising approach is to adhere as closely as possible to commonly used teaching instruments and to develop easy-to-use, easy-to-customise software platforms.

Figure 1 The virtual classroom environment

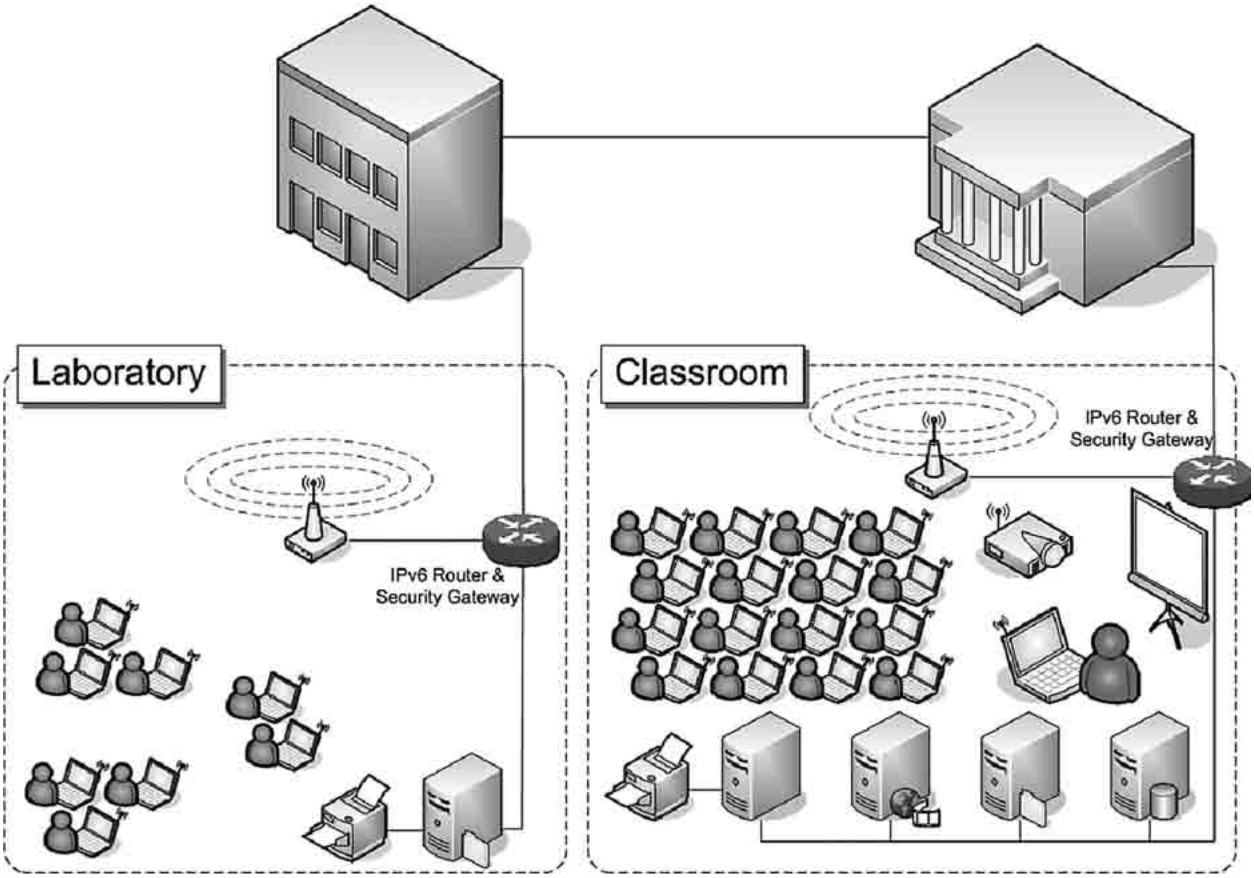
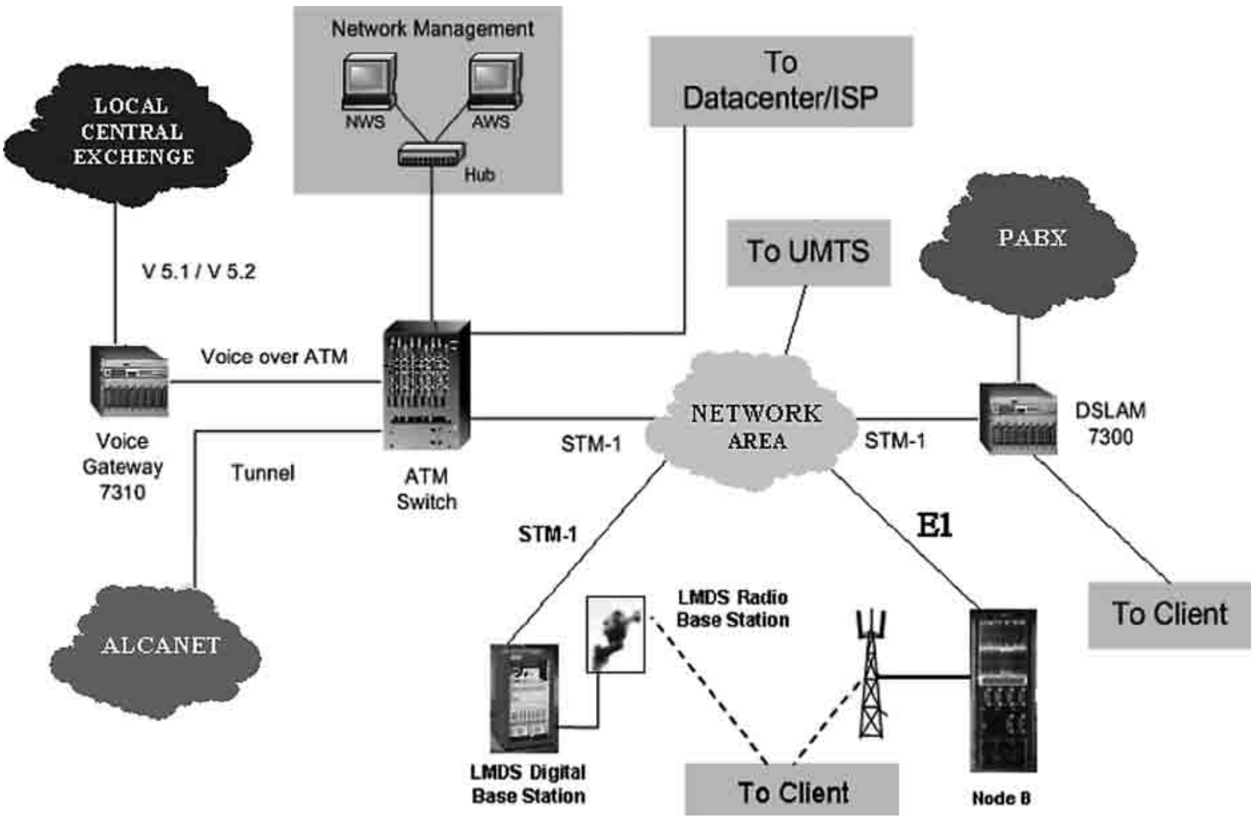


Figure 2 The Alcatel Italia Multimedia Communication Centre (MMC)



References

Albaugh P (1999). The role of skepticism in preparing teachers for the implementation of technology. In *Proceedings of the Society for Information Technology and Teacher Education International Conference*, 1906–1909.

Blake S *et al*. (1998). *An architecture for differentiated services*. IETF RFC 2475. Reston, VA: Internet Engineering Task Force. Available via www.ietf.org, accessed 12 September 2005.

Bernet Y *et al*. (2000). *A framework for integrated services operation over diffserv networks*. IETF RFC 2998. Reston, VA: Internet Engineering Task Force. Available via www.ietf.org, accessed 12 September 2005.

Durham D *et al*. (2000). The COPS (Common Open Policy Service) Protocol. IETF RFC 2748. Reston, VA: Internet Engineering Task Force. Available via www.ietf.org, accessed 12 September 2005.

ISO/IEC Standards Committee (2001). *MPEG–4 – coding of audio-visual objects*. ISO/IEC14496. Geneva: International Organization for Standardization/International Electrotechnical Commission.

Peters O and Collis B (2000). A constructivist framework for WWW-based learning environments that combine streaming media and WWW functionalities. In *Proceedings of the World Conference on Educational Multimedia, Hypermedia and Telecommunications*, 904–909.

PLS Ramboll Management (2004). *Studies in the context of the E-learning Initiative: virtual models of European universities*. Århus: PLS Ramboll Management.

Requirements for mobile learning games shown on a mobile game prototype

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Abstract

Mobile technologies offer the opportunity to embed learning in a natural environment. This paper describes the design of the mobileGame prototype. The mobileGame explores opportunities to support learning through an orientation game in a university setting. The paper first introduces the scenario and then describes the general architecture of the prototype. The second half of the paper focuses on requirements that have evolved during the design, implementation and testing of the prototype: supporting work on the move poses difficult interface questions – the accuracy of current outdoor and indoor positioning systems is still problematic; and the game requires a near real-time response time. This requires a distribution of functionality and data between the server and the client and a careful design of the interface. The success of the game depends heavily on the extent to which its design (ie the set-up and its rules) motivates the players. A surprising number of user roles surface once the game is implemented in a natural environment.

Keywords
mobile and wireless games, mobile learning, e-learning, computer-supported cooperative play, positioning systems

1 Introduction

Today, we work increasingly with mobile technologies. There are mobile phones for communication nearly everywhere, laptops to work wherever we want and personal digital assistants (PDAs) to get access to information whenever we want. It is just a question of time until mobile technologies are used for other aspects of our life. One of these is learning. Sharples, Corlett and Westmancott (2002) say that the technology for mobile learning is now available. Research in the area of mobile learning, however, is still in its early stages, but the results show that mobile technology provides a new way of learning.

One of these new ways could be the integration of learning and playing, supported by a mobile environment. There are a few systems that integrate playing and learning such as the Cooties Game or Geney (Savill-Smith and Kent 2003), but they focus on role-play or simulation. Prototypes and commercial versions of location-based games set in a real-life environment, like CYSMN (Benford *et al*. 2003), Pirates! (Björk *et al*. 2001) or Mogi (Hall 2004), show that people like to play with the new options, but these games are focused only on entertainment. Below we describe a scenario which shows a new way of learning, combining location-based games and mobile learning. This scenario was implemented in a prototype for testing. We describe the architecture of this prototype before we discuss the requirements which we found in our first test with users.

2 The scenario

Mark Finder is a new student at the University of Zurich and has just arrived for the orientation day. This year, the traditional orientation rally is electronically supplemented with handheld devices. The orientation rally is a fun event which helps students to get to know the university and its surroundings. Therefore, the rally will lead all participants through an area with several tasks to fulfil at certain spots. Mark is asked to fill in an online form with his personal profile (nationality, gender, age, personal interests, hobbies, favourite food, etc). All new participating students are automatically grouped by their profiles in order to obtain homogeneous groups. Mark meets five other students with similar interests in theatre, jazz, history and biking. Each group receives a handheld computer.

Figure 1
Playing the game

During the orientation rally, each group receives different tasks referring to significant places, people and events (explained below). The handheld device shows the current position of the group on the digital map of the university (see **Figure 1**).

When the group enters a building, the outdoor map switches to an indoor map of that building. The whole rally is structured as a cooperative and competitive game. The competitive element is based on hunting rules: each group tries to catch another group and equally, is hunted by another group.[1] The handheld device shows each group where its hunter and its prey are located. Cooperation rules force group members to meet members from other groups as well as teachers and to exchange information with them – again, they are supported with location-based information on their displays. The tasks given to them provide them with basic information on university life. There are the following types of task.

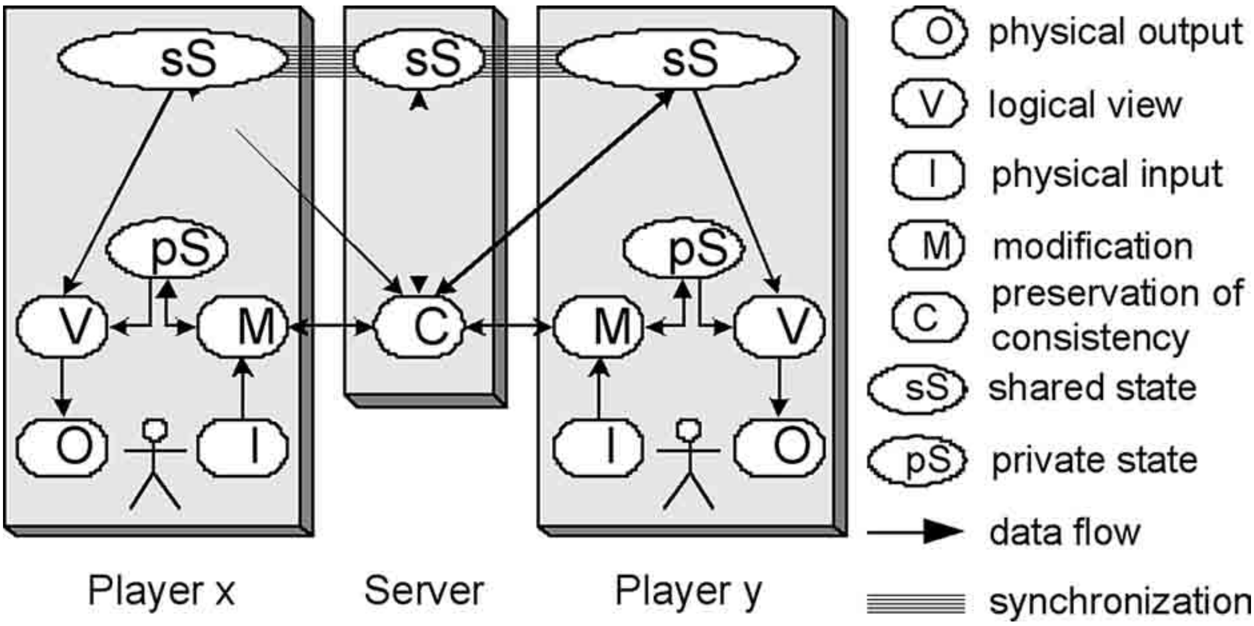
- *Significant place tasks*: the students have to find important places such as the library, the cafeteria or the laboratories. At each location, they have to perform a typical task (find a book, have lunch, etc). The specific tasks are context-dependent (they depend not only on the location, but also on the time of day, or they build on the activity of a previous group). The task execution is supported by the handheld device (eg serving as a front end to the library information system or providing them with needed information).
- *Significant people tasks*: the students have to find important people at the university (the president, the study coordinator, the caretaker) and interview them on their jobs – these people either actually participate in the game or are played by older students. If those people are typically mobile, they can be located by a mobile device.
- *Significant event tasks*: the significant events can be scheduled or be 'by surprise'. Scheduled events include introductory lectures and courses. Here tasks relate to the organisation of studies (eg set up a course schedule; how to find important information) and some initial content. Unscheduled events include 'spontaneous' welcome parties by student groups, but also the sign-up of each group member to important university services (eg computer account, library card).

Each task requires the group to answer one or two simple questions displayed on the handheld device. For example, one task might be to find the cafeteria. There they get the question 'What is the price of an apple pie?' They will not get the next task until the correct answer is given.

In addition to the game, the students can annotate real objects with virtual 'post-its'. Other groups can read these short messages and answer with their own 'post-its'. Spectators are also integrated. They can watch the game via a web browser. The groups and the spectators can use the integrated instant messenger to communicate with each other.

The mobileGame scenario substitutes the teacher with a PDA that gives tasks to the student. This corresponds to constructivist theory, which requires the teacher to act as a coach. Learners are encouraged by the tasks to act on their own, in the real-world context of the university. They individually construct their own knowledge of the university. Additionally, the game is played by groups of students with the same interests. This links the game with a suitable social setting, as postulated by the situated cognition theory (Hutchins 1994).

Figure 2 Architecture for distribution with centralised coordination



3 The mobileGame prototype

The scenario describes a sort of synchronous collaboration between the players. So we decided to derive the architecture of the mobileGame prototype from a common computer-supported cooperative work (CSCW) architecture concept for synchronous collaboration (see **Figure 2**; Schümmer and Schluckmann 2001). There are the clients with their own private view of the game in progress. Generally, all relevant data is stored on the client side, so the player could act even if there is no connection to the server available. The server works as the central coordination point for the whole game. Dynamic changes in the game are transferred to the server which distributes the data. Awareness regarding the accuracy of the transferred information is handled by a timestamp mechanism. Thus, a player always knows if s/he is working on 'fresh' data or if the messages from other players are obsolete.

3.1 The technique of the prototype

The architecture integrates three components: the mobile client on the PDA, the web client for a browser and the server. The mobile client runs in a Java virtual machine[2] on the PDA. It communicates with the server via Remote Method Invocation (RMI). For example, the client receives information about the current position of the group, new tasks to solve, events or messages. The client displays the data on the screen of the PDA. If the group captures other groups of players or solves tasks, this information is sent back to the server. Annotations are displayed in the Pocket Internet Explorer. The browser exchanges data with the server over HyperText Transfer Protocol (HTTP). On the PDA, there also runs an instance of the Ekahau client. This program is independent from our own code and communicates with the Ekahau positioning engine autonomously. If the playing ground is not completely covered by a Wireless Local Area Network (WLAN), the client can also get positioning information over a serial connection to a Global Positioning System (GPS) receiver.

The web client is a Java applet running in the Java virtual machine of a web browser. It requires the Java 1.4 plug-in from Sun. The applet shows the current status of the game and allows chatting between the playing groups. The communication with the server is realised over HTTP.

The server components are also written in Java. As described above, it communicates with the different clients over RMI and HTTP. For the communication over HTTP, we use the Jetty servlet engine, a simple but efficient servlet container. MySQL and the Apache Object/Relational Bridge (OJB)[3] are used for the persistent storage of game data. The server gets the positioning information of the playing groups from the Ekahau positioning engine, which itself gets them from the Ekahau clients running on the PDAs.

3.2 Positioning of the client

There are two ways to localise the position of the client. The first one is used in outdoor areas, where no WLAN is available. A GPS receiver is plugged into the PDA which computes its position with the GPS signals only. The problem of GPS positioning is its inaccuracy. The accuracy ranges from 3m to 100m, depending on the weather and the surroundings. There are many unwanted side-effects like position indicators jumping over the whole digital map or groups not being available at the point shown on the digital map.

The second way, which is much more accurate, is to use the WLAN to compute the position. We used the Ekahau positioning engine for this purpose. The Ekahau client on the PDA sends the information on the available WLAN access points to the Ekahau positioning server. The server computes the position, which is read from the mobileGame server. The accuracy achieved is between 1m and 3m, if four access points are available. The disadvantage is that the engine needs to be calibrated before you can use it. This calibration took up to 1 hour per floor of a building, so you cannot use it 'out of the box'.

4 Requirements and lessons learned

The following requirements are based on a user test which took place at the University of Koblenz. The test was integrated into a presentation day for the Faculty of Computer Sciences. The mobileGame was shown to the visitors and they could play a little game, in which they had to find a hidden PDA.

4.1 Work on the move

The players got a PDA showing a map of two floors, their own position and the position of the PDA that they had to find. Although the map filled 50% of the PDA screen and the floor was only a straight corridor, the players mentioned that it was not possible to move and navigate with the PDA at the same time. If they wanted to look for their current position, they had to stop and look at the PDA. Even though they did not have to interact with the PDA, they had to look down and compare the map on the screen with their surroundings. It is really hard for people to work on the move.

In the mobileGame, the players have to position themselves constantly. Of course, they do not want to stop every 10 seconds and look at the PDA. Therefore, we have done some experiments with head-mounted display that presents information close to the line of sight. This option, however, has two disadvantages: the players have to wear big glasses and not everybody likes to look like a cyborg or a robot. The other disadvantage is the distorted field of vision. There are two kinds of head-mounted display. The first is a little display, which is attached to normal glasses. The second is a pair of big glasses with integrated video input and output. Two video cameras in the glass record parts of the field of vision and display it on two screens in front of the player's eyes. This can be augmented with additional information. Depending on the model, the player either has to refocus the eyes on the little display on the glasses; or wear big glasses which only present a restricted field of vision.

We believe that an audio interface, which gives the user the necessary information through headphones, may be the answer to that problem. Björk *et al.* (2001) have experimented with audio for status information in their game *Pirates!* However, they found that often this information could not be heard because the noise level within the gaming area was too high. So there must be a trade-off between the transmission of information through transient audio and persistent visualisation on the PDA screen.

4.2 Accuracy of positioning

One of the biggest mobile games was *Can you see me now?* designed by Benford *et al.* (2003). Mobile actors hunt virtual players in Sheffield. The positioning system for the actors is based on a GPS. Their main problem was ensuring accuracy of up to 106m, but with some tricks, the actors have managed to overcome this problem. Our prototype uses GPS and WLAN for positioning, as described above, with the result of an accuracy of 3–5m. The players, who need the positioning information for their orientation, have told us that the accuracy was quite good as long they only needed to know their approximate position. As soon as they had to know the exact position of an object – in our test, the position of the hidden PDA – the accuracy was not sufficient. They had to search in up to three rooms for the PDA.

For each domain of positioning, you need a separate system. Global and local systems can be integrated to get a much better result for the players. We are planning to add a third system beside the GPS and the WLAN system, which is based on Radio Frequency Identification (RFID). Points of special interest can be tagged with RFIDs, so a player who reaches this point receives a signal and knows that his/her position is accurate within up to 1m.

4.3 Offline areas and short reaction time

One of the main reactions of the players in the test was that the update time of their position was much too slow. We update their position every 3 seconds, but in this time, the players move 5m or more. This is one of the most important requirements of mobile games. Usually you do not have an area-wide WLAN, so the mobile clients are not always connected to the server. But the players want a near real-time reaction of the client. Game objects, which are changing all the time, like the position of the gamers, have to be updated by client as fast as possible. This means on the one hand, that the mobile game must have a very good caching algorithm; and on the other hand, that a very efficient data transmission strategy is needed.

In our prototype, all static information, such as the game maps, is stored on the PDA. Only the dynamic information, such as a new position or a new task, is transmitted. The PDA gets all the information from the server that it needs for offline work, like the answer on the current task, so that the players can interact even if they are in an area without a WLAN. Additionally, they get the status information about their network status and the status of other players with whom they want to interact.

4.4 Easy-to-use interface

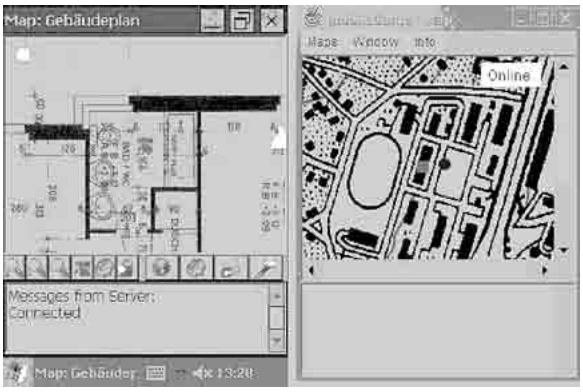
Figure 3 shows the new and the old interface. The first interface uses drop-down menus as on desktop programs. The observation of the players showed that navigation with the drop-down menu and the pen of the PDA is not really intuitive. The use of the PDA is much more like the use of an automat. So we redesigned the GUI and substituted a button bar for the old menu. Now all functions can be reached by one or two clicks. We also use symbols instead of text because they are smaller than text and the users understand symbols much better.

One big problem is still the interface for answering the questions of the task. On the one hand, you can use open questions, which gives the game designer a broad range. Then the users have to write the answer down with the pen and a little virtual keyboard on the PDA, which is hard to use. On the other hand, you can use multiple-choice questions, which restrict the game design, but users can answer questions by simply clicking. At this point in time, we support open questions, multiple-choice questions and questions with sliders, where you can ask for numbers. We think an audio interface could help here too.

4.5 Roles in the game

In the test in Koblenz, we used only one client – the mobile client. The players as well as the game master use the same functions with the same client. Some functions were spontaneously 're-defined' because there were no adequate functions given by the client. After the test, the results were discussed in a meeting with experts. As a result of this discussion, it was agreed that a mobile game needs to support many roles in the game. There is the player, the game master, the spectators, the visitors, the tutors and the actors for special events. Also there is the game designer and administrator supporting the game. All these people need a special client with special functions. At this point in time, we only have a client for the players and for the spectators.

Figure 3
The new and the old graphical user interface (GUI)



5 Ongoing research

The next step of our research was a big user test with new students at the University of Koblenz at the end of April 2004. As described in the scenario (section 2), new students should learn from mobileGame how to live on campus and where to find the most important places. In the presentation at this conference, a first result of this test can be presented. After the analysis of the test, the prototype should be revised. There are plans to test the revised version at the University of Zurich in the autumn of 2004.

References

Benford S, Anastasi R, Flintham M, Drozd A, Crabtree A, Greenhalgh C, Tandavanitj N, Adams M and Row-Farr J (2003). Coping with uncertainty in a location-based game. *IEEE Pervasive Computing Journal*, July–September issue, 34–41.

Björk S, Fals J, Hansson R and Ljungstrand P (2001). *Pirates! Using the physical world as a game board*. Paper presented at the 7th IFIP TC13 Conference on Human–Computer Interaction, 9–13 July, Tokyo, Japan.

Hall J (2004). *Mogi: second generation location-based gaming*. At www.thefeature.com/article?articleid=100501&threshold=–1, accessed 2004.

Hutchins E (1994). *Cognition in the wild*. Cambridge, MA: MIT Press.

Savill-Smith C and Kent P (2003). *The use of palmtop computers for learning. A review of the literature*. London: Learning and Skills Development Agency.

Schümmer J and Schluckmann C (2001). Synchrone Softwarearchitekturenp. In G Schwabe, N Streiz and R Unland (eds) *CSCW-Kompendium*. Heidelberg: Springer Verlag, 297–309.

Sharples M, Corlett D and Westmancott O (2002). The design and implementation of a mobile learning resource. *Personal and Ubiquitous Computing*, 6, 220–234.

Endnotes

1 The didactic reason for hunting rules is to keep the groups moving. Of course there need to be hunting-free areas and times; for example, during courses.

2 This JVM has to support the Personal Java 1.2 specification (http://java.sun.com/products/personaljava/).

3 The OJB is an object/relational mapping tool that allows transparent persistence for Java objects against relational databases. See http://db.apache.org/ojb/

A community of practice? The Toshiba Ambassadors programme

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Abstract

This paper explores Wenger's 'community of practice' concept and relates his theory to a community of practitioners implementing portable and wireless technologies in schools and colleges in the UK.

Keywords
portable, wireless, community of practice, Toshiba

1 Background – information and communications technology (ICT) in schools

Department for Education and Skills (DfES) funding for e-learning in schools in the UK has increased substantially since it began in April 1998. In 2002/03, it totalled £510m compared with a total of £657m over the 4 previous years. In addition, £230m was made available for staff training through the National Opportunities Fund.

A recent Office for Standards in Education (Ofsted) report (2004) entitled *ICT in schools – the impact of government initiatives five years on* is a timely reminder of the constant pressure on educators to demonstrate that the investment in technology is having the required impact on the learning process and outcomes. The report highlights the main positive aspects of the work of The National Grid for Learning including: laptops for teachers, strategic leadership in ICT, Curriculum Online, enhancing subject teaching using ICT, the continued funding of the Regional Broadband Consortium, The Test Bed Project.

The main findings suggest that the continued impact of government initiatives for ICT in schools has been significant. The outcomes of the initiatives are more evident in improvements in pupils' achievements in ICT capability than in their application of this learning in other subjects. The incidence of effective application of ICT in lessons across subjects is, however, increasing slowly but surely.

However, the gap between the best and worst in ICT provision is unacceptably wide and increasing. As yet, the government's aim – for ICT to become embedded in the work of schools – is a reality in only a small minority of schools. More typical is a picture in which pupils' ICT experiences across the curriculum are sporadic and dependent on individual teachers; in many schools, opportunities to exploit technology are not taken on a daily basis.

Some schools have been highlighted in ICT School Portraits, a European initiative (see ICT 2005). Another European initiative is the Toshiba Ambassadors programme and case studies (Toshiba 2005).

2 Toshiba Ambassadors (UK)

Formed in 2001, the Toshiba Ambassadors (UK) are part of a European network of leaders and managers in schools and colleges. The focus of the network is the implementation of wireless networks and the impact on teaching, learning and management.

Toshiba Ambassadors case studies include a number of schools, colleges, Local Education Authorities (LEAs), Education Action Zones (EAZs) and Excellence in Cities institutions (EICs). The pupils of two schools, Leigh City Technology College (CTC) and Arnewood School ran a workshop at the MLEARN Conference in 2003.

Each institution has its own unique experience of implementing wireless technology in teaching and learning.

Toshiba provides the support for the network and the group receives regular visits from Toshiba technical and business development staff.

The most beneficial aspect for the educators is the seminar programme, comprising workshops held three or four times a year and hosted by Toshiba in partnership with one of the Ambassador organisations. The format for the workshops varies, but usually has the following components:

- an overview of recent developments in ICT in education from the DfES
- a research update from the British Educational Communications and Technology Agency (Becta)/ the DfES
- presentations from each of the Ambassadors on recent developments and the evidence for impact
- a technical update from Toshiba
- a presentation from the host organisation on current issues
- feedback from Ambassadors on technical and pedagogical issues in wireless/portability
- new product testing/trialling.

The initiative also has an international dimension: activities have included a study visit to the Benelux countries to exchange ideas with other European Ambassadors and a visit to the Toshiba manufacturing plant in Germany. Several Ambassadors have cooperated on joint project applications and a successful Networked Learning Communities project includes three Ambassadors and a school in South Australia where a Toshiba Ambassador went to teach.

The Ambassadors attend the British Educational Technology Conference and exhibition (BETT) and provide advice and support not only to each other, but also to other schools and colleges which are beginning their wireless journey.

The Ambassadors also play an active role in a variety of other communities including the National Association of Advisers in Computer Education (NAACE), the Association of Learning Technology (ALT), the Becta ICT Research Network, the British Educational Leadership, Administration and Management Society (BELMAS), the Specialist Schools Trust and the e-Learning Foundation.

3 Wireless networking and portability

Wireless networking in schools and the use of portable devices featured in Ofsted's recent report (2004): 'The purchasing of wireless laptops can greatly increase flexibility … the use of laptops on trolleys that can be wirelessly linked to the school network in different parts of the school has had a profound impact where this has been part of a co-ordinated and sustained drive to improve the uptake of ICT across subjects.' The 'e class 2go' was featured at the MLEARN Conference of 2002.

Indeed Perry (2002) suggests that a wireless network can help teachers to:

- work more efficiently
- better support their pupils' learning through their own use of ICT
- use ICT to extract greater value from their teaching
- work wherever and whenever suits them best.

He claims that:

The flexibility of wireless networks and portable computers means that lessons using ICT in depth can take place in ordinary classrooms, allowing it to serve children's learning needs and not dominate them, and to improve teachers' confidence in innovating. Schools have found that the flexibility of wireless networks supports both teachers' teaching and administrative responsibilities highly effectively.

He uses three examples – from the City of York Education Authority, Dorrington Primary School and Sawtry Community Technology College.

A recent Becta report (2004) which analysed the available research into the use of portable ICT devices in teaching and learning summarises the key benefits of using portable devices as follows.

3.1 General benefits

- Portable ICT devices do not dominate in the same way that desktop computers can, and may be more readily integrated into classroom use and across the curriculum with the minimum of disruption to existing practices.
- The use of notebook computers, together with wireless networking technology, allows ICT work to be done in the classroom, saving both space and the time needed to move to specially equipped ICT suites.
- Portability enables students to take work home to continue working, and this can foster greater feelings of ownership over work.

3.2 Benefits for students

- There are gains in understanding and analytical skills, including improvements in reading comprehension.
- Writing skills are developed: this includes spelling, grammar, punctuation, editing and redrafting as well as fluency, originality and elaboration.
- There is increased motivation, organisational skills and responsibility among pupils.
- Portable devices encourage independent and active learning, and self-responsibility for learning.

3.3 Benefits for teachers

- There are gains in ICT literacy skills, confidence and enthusiasm.
- It is easier to plan and prepare lessons and to design materials.
- They have greater ability and confidence to support students' learning with ICT.
- They have access to up-to-date pupil and school data, any time and anywhere.
- It increases the efficiency and accuracy of day-to-day registration of pupils.
- It enhances the professional image that they project to colleagues.

3.4 Benefits for parents

- There is increased involvement in education for parents and, in some cases, improved self-esteem.
- There is increased knowledge of their children's learning and capabilities, owing to an increase in learning activity which is situated in the home.

4 Wenger and communities of practice

Etienne Wenger (1998) poses the question: 'What if the key to complex knowledge challenges faced by most organisations today lies in the age old, utterly familiar, and largely informal social structures known today as communities of practice.

Wenger (2001) further developed the concept and related it to the role of technology in supporting communities in practice, and while the main thrust of this work was the exploration of appropriate technological platforms, some of the key principles resonate with the activities of the Toshiba Ambassadors.

According to Wenger, not every community is a community of practice. The fans who come together in the City Of Manchester Stadium to support the Manchester City football team can be described as a community, but not a community of practice. He asserts that three characteristics are essential:

The domain: since a community of practice is focused on a domain of shared interest, it is not merely a club of friends or a network of connections between people. Membership implies a minimum level of knowledge of that domain – a shared competence that distinguishes members from other people.

The community: in pursuing their interest in their domain, members engage in joint activities and discussions, help each other and share information. That is how they form a community around their domain and build relationships. Having the same job or the same title does not make a community of practice unless the members interact and learn together.

The practice: a community of practice is not merely a community of interest or people who like certain kinds of film, for example. Members of a community of practice develop a shared repertoire of resources, experiences, stories, tools, ways of addressing recurring problems – in short, a shared practice.

Wenger goes on to say that communities of practice are not a novelty. They are not a new solution to existing problems: in fact, they are just as likely to have been involved in the development of these problems. In particular, they are not a design fad, a new kind of organisational unit or a pedagogical device to be implemented. They are about content, learning and a living experience of negotiating meaning, they are not about form. They cannot be legislated into existence or defined by decree. They can be recognised, supported, encouraged and nurtured, but they are not reified designable units. Practice itself is not amenable to design.

5 Conclusion and future work

There are currently 12 members of the Toshiba Ambassadors (UK). There is strong evidence that they have the potential to mature into a community of practice, as Wenger (1998, 2001) defines it. They have formed a symbiotic relationship that has resulted in organisational and individual development. Most importantly, they have had a significant impact on teaching and learning within their own schools and colleges and shared best practice at local, national and international levels.

Further work will focus on the maturation of the community and the addition of new members as well as an evaluation of the impact of the Ambassador programme.

References

Becta (2004). *What the research says about portable ICT devices in teaching and learning*. Coventry: British Educational Communications and Technology Agency.

ICT (2005). *ICT school portraits*. At http://schoolportraits.eur.org, accessed 10 September 2005.

Ofsted (2004). *ICT in schools – the impact of government initiatives five years on*. London: Office for Standards in Education.

Perry D (2002). *Wireless networking in schools*. Coventry: Becta/DfES/Technology College Trust.

Seale J (2004). The development of accessibility practices in e learning: an exploration of communities of practice. *ALT Journal of Research in Learning Technology*, 12(1).

Toshiba (2005). *Toshiba Ambassadors programme*. At www.freedomlearning.co.uk, accessed 10 September 2005.

Wenger E (1998). *Communities of practice: learning, meaning and identity*. New York: Cambridge University Press.

Wenger E (2001). Supporting communities of practice – a survey of community oriented technologies. A shareware report. At www.ewenger.com/tech, accessed 14 September 2005.

PaperLinks – linking printouts to mobile devices

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Abstract

Consuming learning material via mobile devices is deemed to be much more tiring and significantly less efficient than learning from printed material. In the likely scenario that users of online learning environments will escape them by printing out the content, they will typically lose didactically relevant features like interactivity, hyperlinks, colour, video and audio. The PaperLinks approach tries to overcome this dilemma by supporting the learner in accessing such computer-based features while they are reading the corresponding printed material. PaperLinks are systematic augmentations of printed versions of hypermedia content that work in such a way that accessing online features is still only one 'click' away, provided that a mobile device is kept handy.

Keywords
digitally augmented paper, hypermedia, Extensible Stylesheet Language (XSLT)

1 Introduction

While there seems to be a unanimous trend towards e-learning environments, the fact that reading text from computer screens is considered much more fatiguing and significantly less efficient than reading paper text cannot be ignored, especially in the domain of mobile computing with small screen sizes, and particularly in the context of learning, where text is being read over and over (Mills and Weldon 1987; Learn and Mirski 2003). Thus, it is very likely that users will be printing out the content provided by their learning environment, thereby typically losing didactically relevant features like interactivity, hyperlinks, colour, video and audio.

To save the 'didactic power' of such features, it is essential that the reader of paper text is offered immediate access to those computer-based teaching elements when necessary. The efficiency of the access method is absolutely crucial – entering a complete URL via a PDA is certainly not a realistic option.

In section 2, we give an overview of our approach to solving the problem, based on the concept of digitally augmented paper (Guimbretière 2003). In sections 3 and 4 respectively, the architecture of an implementation and specific input modes supported are discussed. An overview of future work concludes the paper (section 5).

2 The PaperLink approach

The concept of PaperLinks is a straightforward attempt to combine the advantages of two very different but complementary media – traditional paper and hypermedia. The challenge is to bridge the gap between the two in a technically sound and usable way. In the first step of the transformation of a hypermedia document to a paper printout, all information which would normally get lost is identified and encoded in the printout as so-called PaperLinks. This augmentation step is totally transparent for the user and will be explained in section 3.

PaperLinks are realised as short numerical identifiers (IDs) associated to objects exclusively available in hypermedia. The crucial part of the concept is to provide a simple and usable way to input such IDs into a mobile device in the course of reading the printed material.

To achieve this, several approaches exist, determining the final representation of the PaperLinks in the printout.

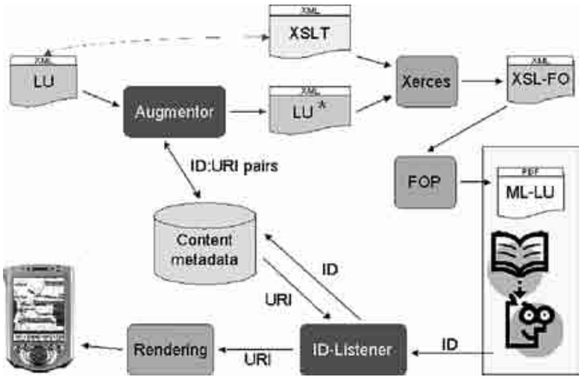
Key: **+** = pros; **–** = cons

- *Direct input* of a short number (eg 2–4 digits) (see also section 4.1)
  - + No special hardware needed
  - + Easy to understand and implement; reliable
  - – Requires manual user input over keyboard or similar
  - – Only valid in a restricted scope
- *Input via barcode-scanner* (pencil)
  - + Fast and convenient
  - – Requires additional (relatively exotic) hardware
  - – Less reliable than direct input
- *Input via voice recognition*
  - + Fast and convenient (numbers represent a small, closed domain)
  - + No exotic hardware needed
  - – Less reliable than direct input
  - – Implementation can be complex on mobile devices

3 Architecture

This description of the general architecture is based on a prototypical implementation in an ongoing national e-learning project [part of the international MOBIlearn initiative (2005)], where the content is organised in small building blocks called 'learning units' (LUs). LUs are available for three different platforms (PC, PDA and Smartphone). Such an LU is the starting point of the augmentation process shown in **Figure 1**.

Figure 1
PaperLink processing



FOP Formatting Object Processor
LU Learning Unit
ML MOBILearn
URI Universal Resource Identifier
Xerces Apache XML parser
XSL Extensible Stylesheet Language
XSL–FO XSL-Formatting Objects
XSLT XSL Transformations

An LU is an XML document, which is the basic input for the 'Augmentor' process, in which all objects of interest (interactions, videos, images, external hyperlinks, links to glossary entries, etc) are identified and unique identifiers (IDs) are generated, constituting their corresponding PaperLinks. These IDs, in combination with an object-discriminating Uniform Resource Identifier (URI), are stored in a database (content metadata). The IDs are embedded into the LU document as XML processing instructions (PI) – thus, the document remains valid with respect to a given Document Type Definition (DTD) or XML Schema. Finally, the augmented document is transformed into a printable PDF document.

The resulting printout – which now contains a specific representation of the PaperLinks (see **Figure 2** opposite) – is 'processed' by the user who has a device with an active 'ID–Listener' nearby. The ID–Listener is a platform-specific process that waits for the user to input PaperLinks, resolving the associated objects and triggering the appropriate rendering processes (eg video player, web browser).

Figure 2 PaperLink representation in printout

4 ID–Listeners implemented

Two ID–Listeners have been implemented in the project so far and are presented in the following sub-sections.

4.1 Touchscreen dial

This implementation of a direct input variant of an ID–Listener is based on the Windows CE-driven Pocket PC platform. Whereas the standard input methods (transcriber, virtual keyboard, etc) are rather cumbersome in use and do require the use of the stylus, PDAs also feature quite a large (240x320 pixel) touch-sensitive display which may also be operated just with fingers. In our implementation, the screen shows a numeric key pad with two additional buttons to cancel and to set bookmarks (**Figure 3**).

Figure 3
Touchscreen dial

For this ID–Listener, all PaperLinks in the printout are represented by numbers of fixed length (four digits in our application) so the corresponding action can be triggered without the need for an explicit input sequence termination. Without any training, such an ID can be entered within a second, so we consider it to be fast and reliable, but of course, the value domain is very limited (0000–9999). While it would be possible to expand this limitation by adding more digits, this would affect every single input operation and significantly decrease the efficiency of the system. Rather, the scope of the IDs visible in the printout is restricted to a single content module which, in our case, has the approximate size of a semester's lecture course (15 x 45 minutes). In this variant, the user has to select the module (thereby establishing the context for ID resolution) before he or she can use the PaperLinks. This adds some set-up cost, but has to be done only once in a learning session and does not hamper every single input operation.

At the moment, PDAs are not really widespread, but there is a strong indication that these devices will quickly be outnumbered by the upcoming Smartphones which it is believed will reach nearly total penetration within the next 3–5 years. As Smartphones offer similar capabilities to PDAs and already feature numeric key pads, they would be ideal for this usage scenario.

4.2 Bluetooth barcode scanner

Our second implementation of an ID–Listener is also for the Pocket PC platform, but uses a Bluetooth-enabled barcode scanner to 'follow' the PaperLinks. The scanner is very lightweight, small in size and can be used like a pen to easily scan the barcodes representing IDs in the augmented printout. The wireless scanner and an example of a PaperLink can be seen in **Figure 4** (overleaf).

Figure 4
Barcode scanner plus PaperLink to an interactive experiment

With this ID–Listener, code length is not an issue, so there is no real problem in associating every desired object with a project global ID, and so the additional step of 'establishing context' can be omitted. On the other hand, this input method is not necessarily faster than the touchscreen dial and the barcode scanner is quite rare and expensive. These are serious problems for e-learning platforms, but the scanner is a nice option for scenarios in which the requirements for initial cost and availability are less oppressive.

5 Future work

Because of the early state of the overall MOBIlearn project, we only have very limited data regarding the usefulness and acceptance of the current PaperLink implementation. A small real-world test with about 30 users will be performed in mid-July 2004. The results will be available from the authors.

The current prototypical implementation of the concept is tailored to the MOBIlearn e-learning environment. If the usability tests yield satisfactory results, there are plans to do a generic implementation which will support any XML-structured content and, as far as possible, HTML-encoded documents too.

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References

Guimbretière F (2003). Paper augmented digital documents. In *Proceedings of the ACM Symposium on User Interface Software and Technology, Vancouver, Canada*. New York: ACM Press, 51–60.

Learn MI and Mirski PJ (2003). Mobile learning – *cui bono*? In M Auer (ed) *Proceedings of the International Workshop on Interactive Computer-aided Learning, September 2003*. Kassel: Kassel University Press.

Mills CB and Weldon LJ (1987). Reading text from computer screens. *ACM Computing Surveys*, 19(4), 329–358.

MOBIlearn (2005). Website. At www.mobilearn.at or www.mobilearn.org

Adaptive mobile learning systems – the essential issues from the design perspective

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Abstract

This paper introduces questions that are important when designing adaptive mobile learning systems. Adaptivity is defined here as one form of adaptation; or as a quality of a system to automatically and autonomically regulate and organise its functioning, the appearance of its UI and the order of information it offers. The most important thing is to weigh the usefulness or limitations of adaptivity in learning systems. Other essential questions include issues of choice between different adaptive techniques and choosing the foundation for them – in this case, user modelling; and the challenges of gathering information on learners.

Keywords
mobile learning, adaptivity, user modelling

1 Why or when is adaptivity needed in mobile learning systems?

Learning through mobile devices with small screens requires more from the content management and from the user interface (UI) than is required in more traditional environments, since there is a large variety of terminals (more than in the case of PCs, for example) and the functionality of networks (coverage and bandwidth) varies as well. Adaptivity can be defined as one form of adaptation or as a quality of a system to automatically and autonomically regulate or organise its functioning, the appearance of its UI and the order of information that it offers. Defined this way, it is close to the artificial intelligence (AI) research that has been done since the 1950s (see eg Self 1988), where problems relating to knowledge-based systems and inferencing are important themes [see also research on uncertainty in AI (UAI 2005)].

Combining adaptivity and mobile learning means from the point of view of learning that:

- the screen space may be very limited and the functions may be difficult to control
- the learning online may not be possible at all times or everywhere
- the learning may be restricted in terms of availability (ie because of the costs of data transfer or the skills needed to use the devices).

Even if we think about mobility as does Cooper (2002) – ie as learning independent of a certain place or time; learning in any place, sitting or standing, but not necessarily as learning on the go – the devotion of time and conscious attention can likewise be very limited, and the context can affect the learning in a number of ways. These are challenges posed by mobility to the design of mobile learning systems that can be met – at least in some ways – through applying adaptivity in the learning systems.

Furthermore, even though with mobile devices learners are able to share information and organise tasks and other educational activities in new ways, all this is happening in existing social environments, and with existing patterns of interaction, and in existing cultures. From the designer's point of view, it is important to consider mobile computers not only as 'dialogue partners', but also to consider the changing roles of learners and teachers and types of activity when we are designing mobile learning systems. The technology itself should adapt to the learning needs (Milrad 2003). In this sense, adaptivity can be seen as a general feature of technology, and not only a property of a mobile (learning) system.

However, adaptivity is not necessarily only an asset: if improperly applied, it can diminish the controllability and predictability of the application and its functions (Jameson 2001).

In the worst case scenario, adaptive changes can make learning harder if the system works in an unstable way and users then need to become aware even of the actions that they are accustomed to perform automatically (see Kramer, Norotha and Vergo 2000). In this respect, the biggest problem usually is that adaptivity is just an additional 'feature' that is built onto the system later on, or a need that emerges during the construction process. Instead, adaptivity-related research questions and related needs should be integrated into the early phases, since 'research methods should not be selected until a researcher is clear about his/her research goals as well as the nature of the research questions to be addressed within a particular study' (Reeves 2000). In our opinion, this applies to adaptive learning system design as well.

Different theories of learning have effects on the design: they produce different kinds of solution in the adaptive mobile learning system. These alternatives should be evaluated at the beginning of the design process. Reeves (1997) has introduced a model of the 14 pedagogical dimensions for evaluating different forms of computer-based education (CBE). The dimensions can be used also for comparing different implementations of CBE. They include: pedagogical philosophy, teacher's role, learner control and user activity. A mobile learning system is one form of CBE and therefore the important decision is whether the learning is going to be learner-centred or controlled by a teacher – or possibly by the system. Another dimension worth considering is learner activity (or 'user activity' in Reeves's model).

2 User modelling as a basis for adaptivity

Most adaptive techniques are based on user modelling; Benyon and Murray (1993) even claim it has to be an integral part of any adaptive system. In the case of mobile learning, learner modelling can be quite challenging because it can include so many different, very complicated factors. Factors related to the learners – preferences, interests, goals, cognitive or learning styles or other traits – present challenges for modelling, not only because there are very few (computer-applicable) methods of identifying them, but also because they can vary and change over time (Schwab and Kobsa 2002). Adaptivity can be linked to these factors in many ways; for example, by saving the learning histories of learners and using them to make assumptions on the learners' progress, the system could help a learner to find more easily the functions they customarily use, or learning material they still have not found but others have (see also Schwab and Kobsa 2000 on group-based modelling and Bayesian networks).

Context may seem at first sight an easy part of modelling, but it is not: contexts affect people's activities mainly through the process of interpreting the contexts (eg Berger and Luckmann 1991) and are therefore closely tied in with factors related to learners. However, learning can be supported with adaptivity without too much effort – for example, through ordering information about a) the locations of learning opportunities; or b) experts according to their physical proximity. On the other hand, factors like the experience (or lack of it) of learners in using the system or in terms of learning content provide more interesting and more meaningful starting points for modelling the contexts. For instance, in adaptive mobile learning environments, learners can be offered information about other people by organising it according to their availability for cooperation (students), or advice (experts, instructors), or according to their closeness in the physical space.

Device-related factors refer here to the differences between different kinds of mobile device and the varying size of their displays, input and output methods and their limitations in presenting information. In mobile learning, it would be useful for learners to know, for example, if some learning material cannot be presented due to lack of graphical display; or if the loading of pictures takes a considerable amount of time due to low bandwidth. These factors are so numerous that the first difficulty is choosing which of them are the most important. Second, it is also difficult to decide how exactly they should be made use of when designing adaptivity.

3 Methods of modelling the user

Apart from the methods for making assumptions about the devices used, the users and their context, user modelling requires two other kinds of method:

- one for acquiring information, or making observations and assumptions based on them, about the users (ie upward inference); for example, input automatically or by learners, or by asking the learner to confirm automatic observations.
- one for making more assumptions about users based on the assumptions made by the first method (ie downward inference) (Jameson 2001). Moreover, a method for validating the user model would be valuable (Dillenbourg and Self 1992).

Different methods have different benefits and requirements for qualities of data. The particular method that is applied can depend, for example, on how well the users' behaviour in the system is known (Jameson 2001). In the case of mobile learning, one could think that there is not enough knowledge to model the learners' behaviour in mobile learning environments, as they are so new. However, there is a lot of knowledge about people's behaviour in web-based learning environments that can be at least partly applied to mobile environments (see Benyon and Murray 1993). However, taking a decision between (a) content-based methods (ie categorising the content) an(d b) collaborative methods (ie based on other people's choices of the content) that depend on the number of learners can be more crucial in mobile learning systems, since the collaborative methods require lots of learners or lots of action in the system. This may be a problem in mobile learning, at least when starting up a new system or introducing new material.

4 Conclusions

The challenges posed by mobility to the design of mobile learning systems can be met through applying adaptivity in the learning systems, but it is not easy, since adaptivity in mobile learning can refer to a host of different features, methods of organising, automatic functions, etc, the purpose of which is to encode and translate information between 'two interacting agents (eg a human and a computer) who possess an incomplete understanding of the other's knowledge' (Chignell and Hancock 1988). The essential issues concern mainly:

- the actual need for adaptivity
- the choice of theoretical background for learning
- the kind of data needed as the base for user modelling
- advance knowledge of the behaviour of learners in the system
- the suitability of the learning material for classification
- the assessed quantity of activity in the system.

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References

Benyon DR and Murray DM (1993). Applying user modelling to human–computer interaction design. *AI Review*, 6, 43–69. At www.dcs.napier.ac.uk/~dbenyon/AIReview.pdf

Berger PL and Luckmann T (1991). *The social construction of reality: a treatise of the sociology of knowledge*. Garden City, NY: Anchor Books.

Chignell MH and Hancock PA (1988). Intelligent interfaces. In M Helander (ed.) *Handbook of Human–Computer Interaction*. Amsterdam: Elsevier Science Publishers BV.

Cooper G (2002). The mutable mobile: social theory in the wireless world. In B Brown, N Green and R Harper (eds) *Wireless World*. London: Springer–Verlag.

Dillenbourg P and Self J (1992). A framework for learning modelling. *Interactive Learning Environments*, 2(2), 111–137.

Jameson A (2001). *Designing systems that adapt to their users*. Notes from tutorial held at the Conference on Human Factors in Computing Systems, Seattle, 31 March–5 April.

Kramer J, Norotha S and Vergo J (2000). A user-centered design approach to personalization. *Communications of ACM*, 43(8), 45–51.

Milrad M (2003). Mobile learning: challenges, perspectives, and reality. In K Nyíri (ed.) *Mobile learning. Essays on philosophy, psychology and education*. Vienna: Passagen Verlag, 151–164.

Papert S (1980). *Mindstorms: children, computers and powerful ideas*. Brighton: Harvester Press.

Reeves T (1997). *Evaluating what really matters in computer-based education*. At www.educationau.edu.au/archives/CP/reeves.htm

Reeves T (2000). Enhancing the worth of instructional technology research through 'design experiments' and other development research strategies. In *International Perspectives on Instructional Technology Research for the 21st Century Symposium*. New Orleans: American Educational Research Association.

Self JA (ed.) (1998). *Artificial intelligence and human learning: intelligent computer-aided instruction*. London: Chapman and Hall.

Schwab I and Kobsa A (2002). Adaptivity through unobstrusive learning. *Kunstliche Intelligenz*, 2002/03, 5–9.

UAI (2005). *Uncertainty in artificial intelligence* website. At www.sis.pitt.edu/~dsl/UAI/

Building a wireless learning management system

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Abstract

For over a year, the Consortium for Post-Compulsory Education and Training managed learning environment (MLE) project has been implementing a learning management system (LMS) across the north of England. Learners and tutors in colleges often lack the equipment needed for successful e-learning. Our project has been involved with providing resources for the sharing of materials, and the means to use them via a wireless LMS. The LMS includes many useful tools and resources, and the wireless LMS/MLE is intended to help overcome obstacles to using IT and learning technology.

Keywords
LMS, wireless

Background

The Consortium for Post-Compulsory Education and Training delivers the same University of Huddersfield teacher training qualifications through partners in 36 different locations across the north of England. The programmes require that all learners have a positive and equivalent experience of e-learning but, despite the best efforts of programme managers, the actual patterns of access and use have shown significant (and unacceptable) diversity in student experience with web-based learning activities.

Definition of the problem

Reasons for the variation have included the availability of hardware and the disposition of tutors (two things that have not been unrelated). Another difficulty has been the need to book IT rooms in colleges to use e-learning resources. This can often involve a fair bit of advance planning on the tutor's behalf, and the lesson has to be tailored to fill the IT time booked.

On this basis, the Consortium is now providing wireless facilities for engagement with its managed learning environment among all its partners.

The wireless networks are in the form of trolleys containing laptops that can be used in any classroom that is within 50 metres of an internet connection, and this facility is designed to undermine barriers to use of web-based opportunities, (including a virtual learning environment and a digital repository). The critical issue now is the extent to which flexibility is related to utility.

Trials and training with the wireless LMS

The reluctance of tutors to use the LMS has been passed on to their learners. Even though training has been provided for the resources available, often the information has not been passed on to learners. This creates difficulties disseminating important information and implementing learning technology resources.

Recently, our training and awareness raising has involved a wireless laptop trolley. Our students have expressed excitement and an eagerness to use the laptops. The wireless nature of the laptops adds a novelty value that captures their interest. Learners gain hands-on experience of the LMS and learning resources using the wireless equipment. The focus is on discovery learning rather than instruction.

First findings

So far we have found from our feedback with tutors that they are positive about the wireless laptops. For them it will mean the chance to use the LMS and learning technology resources in any classroom. Often IT rooms are not considered suitable for teaching purposes.

Our students are very enthusiastic and impressed that their colleges are receiving this sort of equipment. It is important for our project that we encourage new teachers to use learning technology in their teaching. For these student teachers, it is important that they can use this learning technology in situations that suit their teaching purposes. We have found from our trial events that these needs can by met by a wireless LMS.

Context awareness for MOBIlearn: creating an engaging learning experience in an art museum

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Abstract

The MOBIlearn project aims to develop a reusable architecture for delivering mobile learning experiences. A key component of this architecture is a context-awareness subsystem that is intended to tailor the content and options made available to a learner, depending on their current situation, preferences and learning history. The context-awareness subsystem has been developed alongside a hierarchical model of context, and has been subjected to formative evaluation. With reference to our context model, preliminary user trials and input from museum staff, we describe the planned deployment of this system in an art museum learning scenario.

Keywords
context awareness, mobile learning

1 Context awareness for m-learning

Context-aware computing (for a recent review, see Chen and Kotz 2000) has a lot to offer mobile learning. By taking account of the learner's surroundings, we can create engaging learning experiences, providing content and options that are tailored to the current context.

One of the aims of the MOBIlearn project is to create an architecture for mobile learning that includes context-aware recommendations of content, options and services. Work so far has produced a hierarchical model of context (Lonsdale *et al*. 2004) and we have performed some preliminary formative studies of the system (Beale and Lonsdale 2004).

Within the MOBIlearn project, we have developed several learning scenarios designed to permit the deployment and testing of the system, including the context-awareness subsystem. Here we present our plans for deploying and evaluating our context-awareness architecture for students in an art museum. This research is work in progress, currently being developed and planned for deployment in a local museum in September 2004.

1.1 Museum scenario

In our art museum scenario, two students visit the museum with a number of goals. Our aim is to support them in carrying out the following activities:

- planning the visit according to personal interest and requirements
- reaching the area of interest as quickly as possible
- knowing exactly where co-learners, guides, etc, are located in the museum
- viewing a catalogue of works by a particular artist
- receiving detailed information about the work
- receiving information about the artist
- receiving information on other artists belonging to the same period of history
- using an audio guide on the mobile device
- downloading and saving information relating to the work of art
- adding comments/notes next to each work
- communicating with other learners and sharing opinions.

2 Implementation

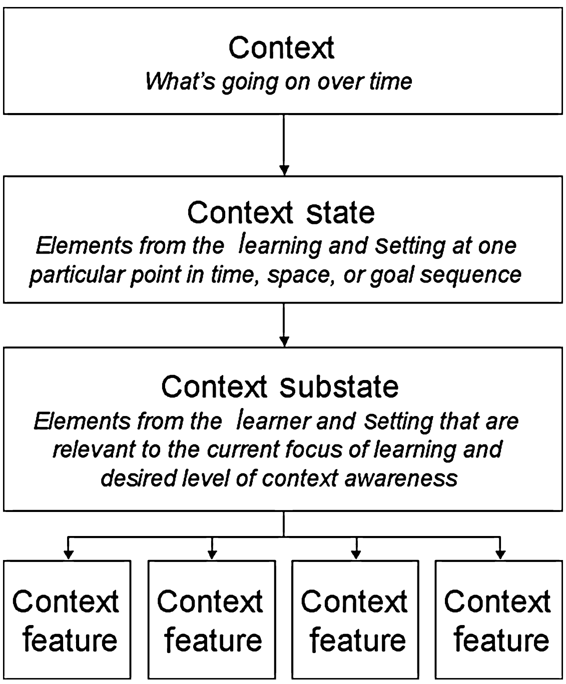
The context-awareness system is implemented as a web service in Java, running under a Tomcat server. We have defined appropriate Extensible Markup Language (XML) Schemas for sending and receiving contextual information, and for providing recommendations to the context delivery subsystems. This work has been driven and informed by our original context model, web services architecture standards and pragmatic concerns for the MOBIlearn architecture as a whole.

2.1 Context model

There is growing recognition of the need for flexible, scalable, reusable models of context that can be deployed for a range of applications. In MOBIlearn, we have been working to produce a reusable model of context for mobile learning applications (see Beale and Lonsdale 2004; Lonsdale *et al.* 2004). There have also been calls for a reconceptualisation of context to represent better the sociocultural aspects of activity, moving away from the predominantly technology-centred approaches to context (Lueg 2002a, 2002b; Dourish 2004).

For MOBIlearn, the purpose of context awareness is to enable learning on mobile devices, and so our approach to describing context and applying this description to producing a usable software architecture is based on this focus. **Figure 1** shows the basic hierarchy for our description of context.

Figure 1
Context model hierarchy



Instead of a rigid definition, our intention is to provide a hierarchical description of context as a *dynamic process with historical dependencies*. By this, we mean that context is a set of changing relationships that may be shaped by the history of those relationships. For example, learners visiting a museum for the second time could have their content recommendations influenced by their activities on a previous visit. More details of our context model can be found in Beale and Lonsdale (2004).

Contextual information is made available to other components of the MOBIlearn system by means of XML documents in an agreed format. At any given time, the current context state is represented as a nested set of context features, all described in XML form. An XML Schema for this XML object is an agreed format that allows all components of the MOBIlearn architecture to access this information as and when it is required. Storage of a set of timestamped XML context objects provides the historical context trace that can be inspected and used by subsequent sessions.

2.2 Approach

Much of the current work on context awareness is technologically driven – that is, systems are developed to take account of the capabilities of the available technology, but there is currently a debate about the exact nature of 'context' for context-aware computing (see eg Dourish 2004). Our aim, in MOBIlearn, is to produce a learner-centred approach to context awareness by including contextual elements that are usable and useful for a given learning scenario. These elements also need to be available from either the environment, a learner model/profile, or directly from the learners themselves. We aim to involve the users in the process of determining and using contextual information by consulting them for information and by making their current derived context both open for inspection and modifiable.

2.3 Elements of context

What is becoming clear is that there are difficulties in implementing context awareness. First, how do we get hold of contextual information; and second, what do we do with it once we have it?

Within the MOBIlearn project, we are centreing our designs on specific learning scenarios. At present, we are working on deploying the system in an art museum setting.

For this scenario, the context-awareness system is being set up to take account of several contextual elements from both the environment and the learner. These contextual elements will be used to derive a usable *context substate* (see Lonsdale *et al*. 2004). Elements to be used in the context-awareness subsystem include:

- current learning topic: this will be either explicitly indicated by the learner, or obtained from his/her profile
- time spent on each artefact: our location-tracking system not only tracks learners' locations, it also times how long they spend in any one position. Standing in front of an artefact for a longer period is used to infer a higher level of interest and content recommendations are updated accordingly
- artefacts or content annotated (through the MOBIlearn system on a handheld device): the MOBIlearn system supports the annotation of content and also of artefacts themselves (a form of virtual graffiti) – this information will be tracked by the context-awareness system to provide relevant recommendations (eg recommending items that have been annotated by friends)
- content items shared with others (through the MOBIlearn system on a handheld device): the MOBIlearn system supports the sharing of content with other learners – this activity will be tracked and used as a source of contextual information.

These elements of context will interact to give us a useful way of determining what is appropriate to show the user. For example, the time spent looking at each painting will be used to derive a measure of 'interest'. A low level of interest will mean that only the title and artist of the current artefact will be shown. However, if the subject of the current artefact matches the user's current learning goal, then the system will assume a higher level of interest and show more detailed information. The user will also be able to override the system. For example, if their goals change during the session and this is not reflected by their current profile, then they will be able to specify their interests, or revert to a default content delivery that is not customised in any way.

2.4 Issues raised by stakeholders – what do we know about people's behaviour in museums?

Museum curators

We have engaged with the stakeholders of the museum experience by inviting input from the curators of the museum in which we plan to deploy the system. Several characteristics of visitor behaviour lend themselves to context-aware support.

- *No follow-up, no introduction*: visitors to a museum typically have little or no lead up to their visit, and are subsequently unprepared for the materials they encounter. Similarly, there is no opportunity for them to follow up their visit. The visit itself must be designed to accommodate the lack of lead-in and lead-out activities.
- *Lack of focused interest*: museums contain many items, relating to a wide range of topics. Visitors enter exhibition spaces and take in the collection, but often fail to give any specific attention to particular items. Being able to point them in the right direction with context awareness will, it is hoped, be an effective way of focusing their attention.
- *How can we present the right level of information to each person?* Museum visitors come from many different backgrounds and have different goals, interests and experience. It is impossible to pitch the information provided at the right level to satisfy all visitors. The key to this problem is personalising the information we provide, using whatever contextual information we can gather about the visitor.

Issues from user trials

To understand better the impact of context-aware content delivery in an art museum setting, we ran some user trials where learners were given the chance to receive recommendations from the context-awareness system.

The system provided recommendations of content, questions and communication with other learners, depending on the participant's current location and question (selected from a predefined list). For example, a learner standing in front of Botticelli's painting *La Primavera* would see content relevant to that painting near the top of their content list, with the top item being most relevant to *La Primavera and* their current question. If another participant who had already answered the current question was also standing in front of *La Primavera*, the system would suggest talking to them in order to discuss the answer.

During the session, the experimenter employed a 'Wizard of Oz' evaluation method, monitoring each participant's location and updating their client software, using a remote management application. (The Wizard of Oz evaluation method involves the experimenter(s) acting to simulate some or all functionalities of the system, with or without the participants' knowledge, allowing evaluation before a fully functional system is available.) The experimenter was also able to monitor which question each participant was currently working on and which questions had already been answered.

At the end of the session, the concept of context-aware content delivery was discussed with the participants, and they were asked for feedback about their use of the system in an informal, free-form interview.

Feedback was gathered from users about the usefulness and usability of the system. This feedback was used to derive a formative evaluation of our current implementation. The following issues were identified.

- *It worked*: most users were able to find relevant information quickly, and successfully answer the questions.
- *Interface and representations*: many users were confused about what we were trying to represent with the interface, and were not sure why their recommendations were changing or how they could best use the recommendations list to answer the questions.
- *Understanding*: some people were not quite sure why the system did what it did, and were surprised by the constantly changing list of options. Demonstration and explanation did not seem to help with this – when there was a misunderstanding, it was due to a lack of intuitiveness about the display of the context-dependent recommendations.
- *Distraction versus engagement*: offering multiple choices either led to sidetracking or encouraged people to take their exploration of the content further. Both of these outcomes suggest that users were engaging with the experience, but this could become a concern if we are trying to design a specific programme of learning. Options that distract users from their current task focus need to be avoided, and so it is possible that some limits need to be set on exactly how much contextually based recommendation is done.
- *Mixed content*: there is a need to distinguish questions, content and physical resources. Offering recommendations on all of these in a single integrated display seemed to be confusing, especially in combination with the lack of an intuitive, easily grasped model of what was actually going on and why.
- *Temporal context*: context is often used in a snapshot sense – 'What is happening now?', 'Where am I at this moment?', and so on. However, there are many much longer-term aspects to context (eg task, learning progress, life goals) and it is not clear how best to represent and use this information in the context system. The fundamental issue is that we need to be able to model and then provide support for users across multiple activities, episodes and projects, with the history of previous support playing an integral role in determining future actions.

3 Next steps

Several specific challenges for implementing this kind of context-aware experience are apparent.

- How can the context-aware system be supportive in a non-intrusive way?
- How can we make suggestions about content or activities without causing distraction?
- How can we effectively combine various sources of contextual information to provide recommendations appropriate to the goals of: a) the learners; b) the experience designers; c) the system designers; and d) the teachers/docents?

The context-awareness system, along with the other major components of the MOBIlearn system, will be deployed in a local museum in September 2004. There are also ongoing trials of various context-sensing mechanisms at the University of Birmingham.

References

Beale R and Lonsdale P (2004). Mobile context aware systems: the intelligence to support tasks and effectively utilise resources. In *Proceedings of the 6th International Conference on Human–Computer Interaction with Mobile Devices and Services, Glasgow, 13–16 September*, 240–251.

Chen G and Kotz D (2000). *A survey of context-aware mobile computing research.* Technical Report TR2000–381. Hanover, NH: Dartmouth College.

Dourish P (2004). What we talk about when we talk about context. *Personal and Ubiquitous Computing*, 8(1), 19–30.

Lonsdale P, Baber C, Sharples M and Arvanitis T (2004). A context awareness architecture for facilitating mobile learning. In J Attewell and C Savill-Smith (eds) *Learning with mobile devices: research and development – a book of papers*. London: Learning and Skills Development Agency.

Lueg C (2002a). *Looking under the rug on context-aware artefacts and socially adept technologies*. Paper presented at the Workshop on the Philosophy and Design of Socially Adept Technologies at the ACM SIGCHI Conference on Human Factors in Computing Systems, 20–25 April, Minneapolis.

Lueg C (2002b). Operationalizing context in context-aware artefacts: benefits and pitfalls. *Informing Science: Human Technology Interface*, 5(2), 43–47.

The MOTFAL project: mobile technologies for *ad hoc* learning

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Abstract

The Mobile Technologies for *Ad-hoc* Learning (MoTFAL) project is a joint initiative of pedagogical and cognitive science, involving technological experts, educators and psychologists, to research the possibilities of using mobile platforms with internet access for educational purposes at school level. The project designs, develops, tests and evaluates a handheld learning environment based on emerging technology that facilitates on-site learning. The proposed approach cuts across the traditional boundary between the classroom, home and other alternative educational settings (museums, libraries, archaeological and historical sites, etc) as distinct learning environments. The goal is to shift away from classroom learning to 'daylong' learning and to use the mobile technology to facilitate that shift. This paper presents the basic principles of the MoTFAL project, the theoretical background of its development as well as the possibilities for its exploitation for educational purposes.

Keywords
m-learning, mobiles, learning anywhere anytime, handheld devices

1 Introduction

The MoTFAL project is a joint initiative of pedagogical and technological experts, educators and psychologists to research the possibilities of using mobile platforms with internet access for educational purposes at school level. The partnership aims to develop, test and evaluate learning schemes that are implemented within a handheld learning environment, based on emerging technology that facilitates on-site learning, maximising the impact of information that is provided when the motivation of the student is highest.

The MoTFAL learning environment includes full access to digital resources, cognitive tools, knowledge visualisations and software mentors to help with: learning to use devices such as digital cameras; organising and recalling images and the sounds of people and situations; knowledge sharing between students in different environments; using contextual personal tools that change their behaviour based on where they are and the activity in progress.

1.1 On-site learning and learning through mobile technology

Classrooms, textbooks, lectures and training sessions have at least one thing in common. As is characteristic of traditional learning opportunities, they take the learners out of the context of their everyday tasks and other activities and put them into specialised learning contexts. But there is another idea, one that promises to complement traditional dedicated learning situations with 'contextual learning', where learning is a dimension of those everyday tasks, activities and situations. This alternative approach is becoming all the more attractive in the light of current trends in work and learning that emphasise *continuous and just-in-time learning*.

Learning happens in various ways. Students learn in classrooms, but they also learn by exploring streams and parks, trying and failing to perform tasks, talking to friends, etc. Adults learn in many of the same ways, by experience, by involvement, by talking with peers and experts, or by delving into a practical problem. Any experience can be a learning opportunity, but often the resources to make it so are lacking. We are used to thinking of knowledge as something 'stored', 'held', or contained in a 'body of knowledge'.

We are following a different, complementary insight here, that knowledge is something active in situations and contextual in its very nature. Knowledge is something that happens rather than something that is stored and applied when appropriate.

2 Educational point of view

2.1 Educational theories

The educational theories that underlie the development of the educational material as well as the educational framework of the MoTFAL project are as follows.

- *Collaborative learning*: in collaborative learning, students generally work together in groups of two or more. The mobile application of the MoTFAL system enhances students' collaboration, as it gives them the possibility to communicate and cooperate just by using the project's platform.
- *Contextual learning*: contextual learning is learning that occurs in close relationship with actual experience. Its main principle is to motivate students to make connections between knowledge and its application to their lives. In the framework of the MoTFAL project, students have the opportunity to study their curricula in real environments.
- *Autonomous learning*: autonomous and self-directed learning sees learners as responsible owners and managers of their own learning process. The MoTFAL project supports the autonomy of the learners by providing them with a variety of resources and materials, with an open environment for learning and collaboration, and also with opportunities to work alone or with others.
- *Experiential learning*: experiential learning takes place when a person is actively involved in an activity. The MoTFAL project is based on the pedagogical method of experiential learning as it gives students the opportunity to get personally involved in the learning activity.

2.2 Educational scenarios for learning through mobile devices: teaching history – an example

Research on the methods of teaching history in the classroom has shown that the main difficulties that students face relate to the understanding of historical terms, the placement of historical events in space and time, and the proposition of multidimensional causative relationships. They also face difficulties in understanding that historical studies are not political, military or diplomatic events, but the everyday life of people of a particular epoch. Contextual learning in history education and the scenario-design method offer a different approach and perspective to history teaching and learning.

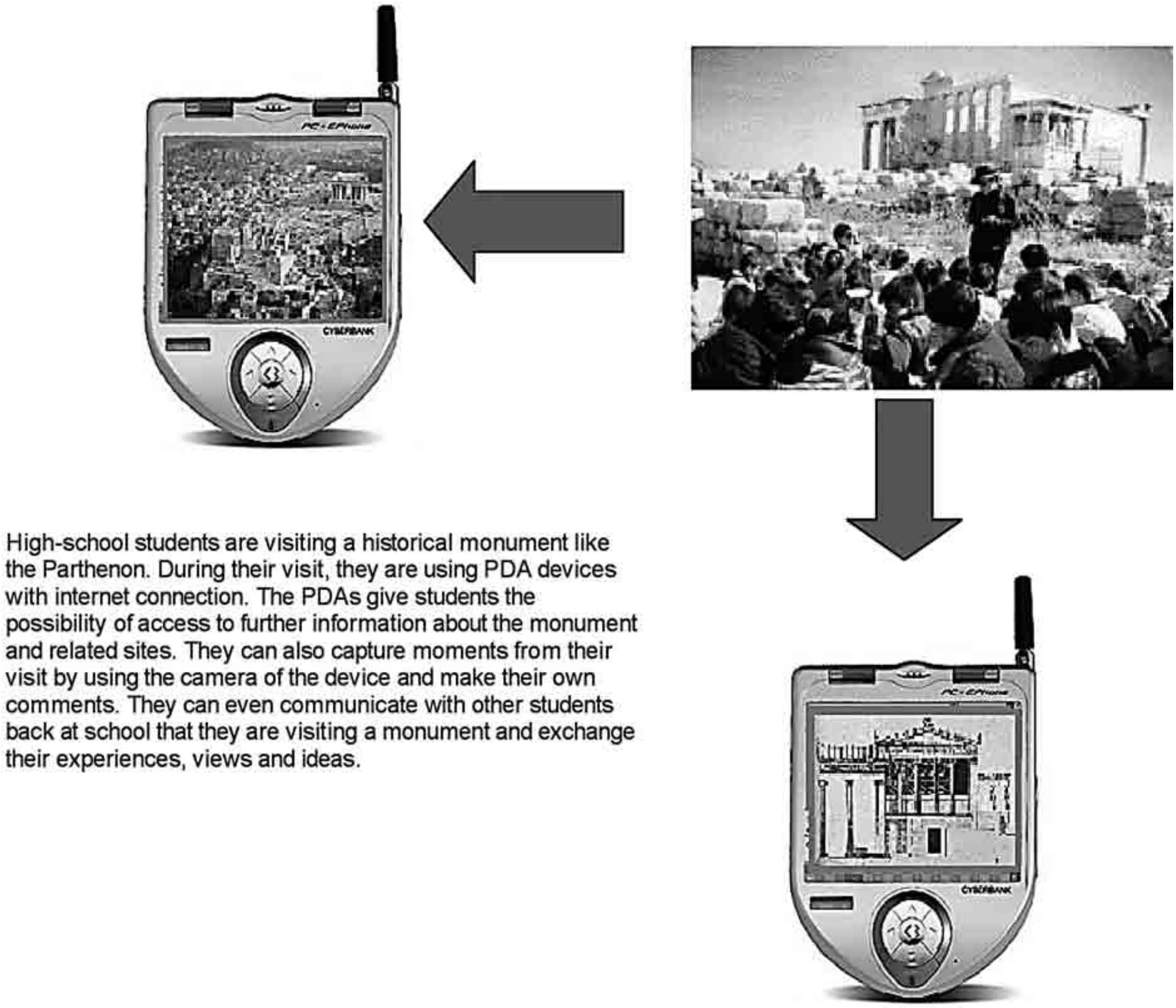
The educational approach which is adopted in the framework of the MoTFAL project is to use scenario-based design methods as a means of defining suitable educational applications of the mobile technology. Scenario building is one of the main design techniques to explore new forms of interaction, in which the physical environment is made to react to human behaviour, using handheld devices as a mediator. In the framework of the MoTFAL project, a series of scenarios as well as the relevant educational material are being designed and developed for use during the implementation phase of the project. An example of a learning scenario is presented below.

The teacher of a high-school class takes the students on a field trip to the Parthenon in Athens. As they are visiting the monument (see **Figure 1** opposite), the students are asked to connect to the specific area of the platform where the teacher has already uploaded the selected material concerning the monument's history. Students are able to see pictures of the monument during the time, enriched by animations. They can also have access to a video showing what the monument looked like and how it was related to the everyday life of the people at that time. Furthermore, students are able to capture moments of their visit with the camera of the device and upload them to the server for future reference, and also add their comments and continue their research by accessing relevant websites during their visit.

3 Technological point of view

A true m-learning environment resembles in principle a sophisticated content and data management system, with development, delivery and control of the content and the learning process. Based on this definition, m-learning should be described as part of an integrated global learning strategy, encompassing a variety of instructional methods, management of learning content and services that supply learners with electronic information and educational content regardless of where they are or the time of day.

Figure 1 A high-school visit to the Parthenon in Athens



3.1 Technical description

The main technological aim of the MoTFAL project is the development of a platform that makes internet services available in any place and at any time. The MoTFAL system is composed of a handheld device, a General Packet Radio Service (GPRS)-capable mobile phone and an open web platform. The open structure of the platform gives teachers the possibility of developing and uploading the teaching material that is useful for their lesson.

The project develops methods and software for storing, retrieving and dynamically synthesising educational modules to meet each learner's goals. To achieve this, the content is broken into small, independent multimedia educational modules. These are stored and retrieved using a database management system. Metadata is used to describe the modules.

Aspects that need to be described using metadata include the format of each module and other technological aspects, its technology requirements, its duration, its role in the learning cycle, etc. The platform services are delivered via an advanced user interface (UI), where the user has to log in. The first major component of the UI is the Personal Learner's Apprentice: this is the core software agent of the system and the main part of the UI, being responsible for interacting with the user. It will:

- manage the user–system dialogue
- proactively suggest content to the student, based on his/her profile
- attend to users' queries about content and suggest modules that meet their declared needs, based on the available educational modules
- break down the user queries and goals into sub-goals to be met by the system and then cooperate with the Response Planner in order to compile a list of suggestions

- monitor the correct delivery of courses and record the user's learning behaviour in order to update his/her profile
- optimise the delivery of content with respect to momentary network availability and device capabilities.

A Multimedia Messaging Platform (MMP) is being developed that will provide two-way communication. The MMP is the second major component of the UI. A web-based application provides the interface for the delivery of the multimedia messages. A web server is used to collect user responses either through the Web or directly from the mobile network.

3.2 Usability issues and the project's technological requirements

Learning through mobile technology has been slow to grow because most wireless devices to date have had small screens, low resolution, slow processing and limited storage capabilities. The solution lies in taking a different approach to streamlining the information and targeting it at the user. The first step towards this solution is to integrate a user-centred investigation into the m-learning system's development cycle. The methodological approach of the MoTFAL project plays a fundamental role in the development of such a system: *user-centred design* and *scenario-based design* are ways of assuring that the final system is appropriate to the user and to the context of use.

The system of the MoTFAL project fulfils the following requirements.

- *Interactivity*: it should provide a means of communication between learners and teachers.
- *Interdisciplinarity*: content should be presented in an interdisciplinary way, incorporating information from different disciplines, thus promoting the idea of informal learning.
- *Unobtrusiveness*: so that the student can capture situations and retrieve knowledge without technology obtruding on the situation.
- *Availability*: its functions should be available anywhere and it should provide seamless communication inside and outside buildings.
- *Adaptability*: it should adapt to the learners' evolving skills and knowledge.
- *Usefulness*: it should be suited to everyday needs for communication, reference and learning.
- *Suitability*: content should correspond to the specific learning needs of users.

4 Conclusions

The MoTFAL partnership considers that the challenge for the future generation of educational systems at the dawn of the third millennium is to develop didactic environments for mobile phones and mobile devices as the availability of mobile devices spreads to more than 1bn users worldwide. The mobile telephone is becoming a trusted personal device with internet access, smart-card usage and a range of possibilities for keeping the learner in touch with the institution's student support services and in contact with learning materials and fellow students, while at home, at work or travelling.

During the implementation of the project, an extensive usability evaluation will be performed that will offer guidelines for the human–computer interaction and psychological content required for the development of the final version of the MoTFAL system. The MoTFAL consortium aims to investigate the impact that handheld technology has on end users' experience of wireless m-learning applications.

References

Anderson JR, Reder LM and Simon HA (1996). Situated learning and education. *Educational Researcher*, 25(4), 5–11.

Aviram A (1993). Autonomy and the flexible school. *International Review of Education*, 39(5), 419–433.

Fleischman J (2001). Going mobile: new technologies in education, *Converge Magazine*, May issue. Available via www.convergemag.com

Norman DA (1999). *The invisible computer*. Cambridge, MA: MIT Press.

Ringland G (2001). *Scenario planning: managing for the future*. Chichester: John Wiley and Sons.

Providing quality of service (QoS) guarantees for e-learning applications over IP networks: the MOICANE project

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Abstract

Enlarging the scope of interaction between universities, research institutions, network equipment manufacturers and network operators to actors distributed in a worldwide environment is crucial to the effective advance of the research community. This synergy puts new requirements on today's access and backbone networks to provide the different data traffic that arises from activities like e-learning and e-training with the adequate level of service.

The MOICANE project (Multiple Organisation Interconnection for Collaborative Advanced Network Experiments) aims to test the effectiveness of the standardised solution for Internet Protocol Quality of Service (IP QoS) – namely IntServ and DiffServ – in a complete integration of access and backbone parts. The project's main goal was to create a distributed testbed, interconnecting several remote network 'islands' characterised by different access technologies and supporting a range of services, such as e-learning, virtual classroom and virtual laboratory.

To provide these QoS services, the MOICANE project addressed and achieved three different objectives: networked cooperation for remote experiments; deployment of diverse access technologies and analysis of their interaction with the core network; set-up of autonomous QoS-capable islands and their interconnection.

Keywords
e-learning, QoS, distributed network

1 Introduction and project objectives

Enlarging the scope of interaction between universities, research institutions, network equipment manufacturers and network operators to actors distributed in a worldwide environment is crucial to the effective advance of the research community. This synergy, based on a 'virtual laboratory' service concept and resulting in a 'networked collaborations' scenario, puts new requirements on today's networks. First, there is a strong need for a variety of flexible and powerful access technologies (fixed, mobile, wireless) in order to extend the service availability everywhere and at any time to a wider pool of actors. Second, the transport capabilities of the network backbone need to be enhanced in order to provide the different traffic types with an adequate level of service.

The MOICANE project (Multiple Organisation Interconnection for Collaborative Advanced Network Experiments) (2005) is a 24-month Information Society Technologies (IST) initiative funded under FP5 of the EU research programme. In terms of technical detail, it implemented a QoS-aware architecture based on a Differentiated Services (DiffServ) (IETF 1998) core network and an Integrated Services (IntServ) (IETF 1997) QoS architecture on the access part of the network. The defined architecture allowed the use of generic signalling protocols, such as RSVP (ReSerVation Protocol), H.323, SIP (Session Initiation Protocol) on the access part of the network. Based on this network concept, network elements (border routers, core routers and bandwidth brokers) were independently developed by other MOICANE partners (universities and research institutions). In order to do this, the project based its efforts on the work of the relevant standardisation bodies and was influenced by the lessons learnt from commercial state-of-the-art network equipment.

The project developed two innovative prototypes of bandwidth broker. This enabled the MOICANE network to provide both static and dynamic resource allocations between different domains. Additionally, the project defined an extension for the COPS (Common Open Policy Service) protocol, called X–COPS, unifying several access network signalling protocols. The Internet Engineering Task Force (IETF) and other bodies have not yet standardised an inter-domain signalling protocol for communication between bandwidth brokers. The project proposed and implemented an inter-domain signalling protocol based on the X–COPS protocol. In this way, the project unified the intra- and inter-domain signalling between IntServ- and DiffServ-based islands, providing a great contribution to the internet community and at the same time, paving the way for the commercial equipment to follow.

Finally, the MOICANE pilot project showed that QoS could be provided to end users transparently, in a tailored and effective way, using the information carried by well-known and widely used signalling protocols. Moving the network intelligence towards the edge and using standard protocols for the network configuration allows a scenario where the customers can still use legacy networked applications and access the advanced services of a MOICANE-like QoS-aware network.

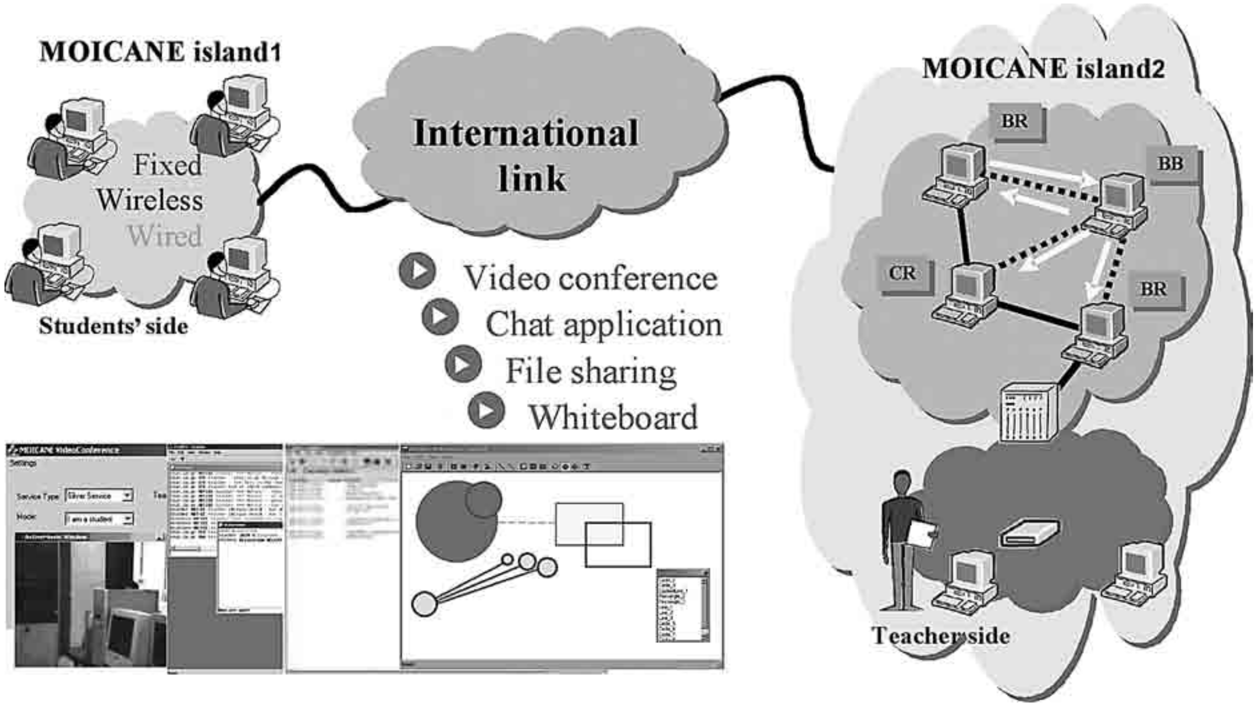
2 Project testbed and e-learning service

In the MOICANE project testbed, composed of different 'islands' – each one independent from the others in terms of administration, geographical location (Athens, Bucharest, Lisbon, Ivrea, Milan and Pisa) and network architectural choices – the network QoS infrastructure needed to be tested first in a local environment, in order to start evaluating locally the QoS model chosen. Each island was based on one or more DiffServ domains and included an integration of the DiffServ section with an IntServ domain. After the islands had been set up and were correctly operating as autonomous entities, they were interconnected through high-speed connections or through the internet. Then their interaction was tested in order to ensure that the QoS guarantees supported by each single island were preserved when traversing one or more domains (in the case of pure DiffServ environments); and when passing from an IntServ to a DiffServ island (in the case of mixed environments). DiffServ domains constituted the backbone of the testbed. Since there were cases where DiffServ and IntServ domains would be present on the same island, it was necessary to develop and integrate devices able to incorporate efficiently the two QoS architectures.

Several effective steps led to the success of this activity. First, there was the deployment and positive test, on each island, of all the modules for QoS provision. This was followed by an efficient dimensioning for the network elements, in terms of buffer, scheduling algorithms, bandwidth allocation and admission control schemes. Hence, the verification of the end-to-end QoS guarantees was maintained when crossing the different islands. Finally, there was the consolidated knowledge and experience in the set-up, configuration, traffic and network engineering and protocol interoperability of IETF's IntServ and DiffServ models, thus exploiting on-site experiences to produce useful information and management criteria suitable for submission to the relevant standards bodies (specifically IETF).

Furthermore, a novel testing methodology, namely Orione (developed by a collaboration between WIND and Tekelec), was adopted to run the evaluation tests from a functional and a performance point of view. These tests were run for the access and core parts of the network, and for each island separately and end-to-end, in order to assess properly both the entire network infrastructure and the QoS perceived by the person using the e-learning and 'virtual classroom' services. A test scenario for the e-learning service, involving two different MOICANE islands, is depicted in **Figure 1** (opposite). The students are located on island1, while on island2 there is the teacher, using his or her personalised application with enhanced capabilities by comparison with the students' version. The two islands are connected by a high-capacity international link.

Figure 1 E-learning service scenario with QoS guarantees



3 Conclusion

The MOICANE project has achieved three different objectives: networked cooperation for remote experiments; deployment of diverse access technologies and analysis of their interaction with the core network; set-up of autonomous QoS-capable islands and their interconnection.

The results collected in the testbed have fully assessed the proposed architecture for e-learning and e-training services. The QoS provided fulfils the requirements of the end user. The developed solution paves the way for a worldwide deployment of virtual collaborative services.

References

IETF (1997). *The use of RSVP with IETF integrated services*. RFC 2210. Reston, VA: Internet Engineering Task Force.

IETF (1998). *An architecture for differentiated services*. RFC 2475. Reston, VA: Internet Engineering Task Force.

MOICANE (2005). *Website*. At www.moicane.com/

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Abstract

This presentation will explain the concept of learning objects and metadata and introduce the eduSource suite of tools, applicable for mobile learning. Learning objects are enabled and made interoperable using mobile and other devices through the use of international standards and specifications. eduSource Canada is a pan-Canadian project which aims to develop the open source infrastructure for a network of learning object repositories. The suite includes metadata guidelines, applications, and hardware specifications. Metadata is essential for promoting semantic interoperability, so the project team has applied the IEEE LOM, creating CanCore, which is a metadata implementation profile which facilitates employment of the LOM (Berners-Lee, Hendler and Lassila, 2001; Geroimenko and Chen, 2002).

Keywords
Learning object, metadata, application profile, interoperability

1 Background

eduSource Canada partners are building a national test bed of linked and interoperable learning object repositories. This project is based on national and international standards. It is bilingual (French/English) and accessible to everyone on the Internet, including those with disabilities. eduSource is providing leadership in the ongoing development of the associated tools, systems, protocols and practices that will support such an infrastructure. Collectively, the contributions of the partners amount to $5,280,000 of the total project value of $9,830,000. CANARIE is contributing up to $4,500,000. The six primary partners are Athabasca University – Canada's Open University, the Netera Alliance, TeleEducation NB, Simon Fraser University – Surrey, Téléuniversité du Québec, and the University of Waterloo.

2 Learning objects and metadata

2.1 A description of learning objects

Learning objects have been defined differently by various researchers. Although there is a wide divergence of opinion, at its core, a learning object is a digital resource that is used in learning. More specifically, the resource would have a lesson encapsulated in it and appropriate metadata. There are different levels of granularity used, ranging from a simple component to a lesson, unit, module, course, or even programme. These learning objects enable learning when they are interoperable among different systems (IMS Learning design specification, 2003) (Norm Friesen, 2001) (R. McGreal, in press; Wiley, 2001).

2.2 What is metadata?

Metadata is often described as being 'data about data'. This description is not particularly useful without examples. A library card is a commonly known type of metadata. The author, title and ISBN code are all fields in this standard metadata format. The principal metadata standard for LOs is the IEEE LTSC LOM. Many organizations such as ADL, ARIADNE, and IMS (ADL, 2003; ARIADNE, 2003; IMS, 2003) have been involved either directly or indirectly in the development of the specifications on which this standard is based (Duval, Hodgins, Sutton and Weibel, 2002; IEEE Learning Technology Standards Committee, 2002; Rory McGreal and Roberts, 2001).
A variety of application profiles for the implementation of these standards, such as SCORM, CanCore and SingCore have been developed (ADL, 2003; Athabasca University, 2003; SingCORE, 2003).

2.3 CanCore metadata implementation profile

The IEEE LOM standard is both complex and general in character. It contains a broad range of elements, and leaves open many possibilities for interpretation. CanCore seeks to simplify, interpret and refine this standard to aid implementers. CanCore provides a great deal of fine-grained information about each element in the LOM (information that takes the form of recommendations, examples, and references to other interpretations). The CanCore element subset, as well as its best practice guidelines, has been created through close consultation with a community of educational participants (French and English). CanCore has been specifically created to facilitate profiling and decision making by those involved in implementation (Athabasca University, 2003; N Friesen, Roberts and Fisher, 2002).

2.4 Conclusion

The eduSource project supports the creation of internationally interoperable repositories for learning objects. These repositories will empower m-learning. As course developers and teachers gain experience in the use of mobile devices and as the number of online courses grows, the importance and necessity of learning objects and the metadata standards that support them will become more apparent. Efficient learning using the ever-expanding multimedia resources of the Internet on the rapidly improving mobile devices will become a reality. From anything and everything to specific digital learning resources, the future of m-learning is inextricably linked with the development of quality learning objects.

References

ADL (2003, 15 February). *Sharable Content Object Reference Model (SCORM)*. Accessed July 14, 2002 from www.adlnet.org/ADLDOCS/Documents/SCORM_1.2_ConformanceReq.pdf

ARIADNE (2003). *Home page*. Accessed July 14, 2002 from http://ariadne.unil.ch

Athabasca University. (2003, 23 April). *CanCore Metadata Guidelines Home Page*. Accessed July 14, 2002 from www.cancore.ca

Berners-Lee T, Hendler J, and Lassila O (2001). The semantic Web [Electronic Version]. *Scientific American, May*. Accessed July 14, 2002 from www.sciam.com/article.cfm?articleID=00048144-10D2-1C70-84A9809EC588EF21

Duval E, Hodgins W, Sutton S and Weibel S L. (2002). Metadata principles and practicalities. *D–Lib Magazine*, 8(4). Accessed July 14, 2002 from www.dlib.org/dlib/april02/weibel/04weibel.html

Friesen N (2001). What are educational objects? *Interactive Learning Environments*, 9(3). Accessed July 14, 2002 from from www.careo.org/documents/objects.html

Friesen N, Roberts A, and Fisher S. (2002). CanCore: Metadata for learning objects. *Canadian Journal of Learning and Technology*, 28(3), 43–53.

Geroimenko Vand Chen C (Eds.). (2002). *Visualizing the semantic web: XML-based Internet and information visualization*. London: Springer–Verlag.

IEEE Learning Technology Standards Committee (2002). *Draft standard for learning object metadata*. Accessed July 14, 2002 from http://ltsc.ieee.org/doc/wg12/LOM_WD6_4.pdf

IMS (2003). *IMS Home page*. Accessed July 14, 2002 from www.imsproject.org

IMS Learning design specification (2003). Accessed July 14, 2002 from http://imsglobal.org/learningdesign/index.cfm

McGreal R (Ed.). (in press). *Online Education Using Learning Objects*. London: Routledge/Falmer.

McGreal R and Roberts, T (2001, October). A primer on metadata for learning objects: Fostering an interoperable environment. *E-Learning*, 2(10). Accessed July 14, 2002, from http://elearningmag.com/ltimagazine/article/articleDetail.jsp?id=2031

SingCORE (2003). *Home Page*. Accessed July 14, 2002 from www.ecc.org.sg/eLearn/MetaData/SingCORE/index.jsp

Wiley D A (2001). *The Instructional Use of Learning Object*. Accessed July 14, 2002 from http://reusability.org/read/

Interactivity in a large class using wireless devices

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Abstract

This paper aims to describe how to make teaching a large class in higher education livelier and more participative by using wireless devices. The paper briefly describes the challenge of teaching a large class and presents the DRIM–AP project (French acronym for Multiple Interactive Radio Devices and Participative Lecture Theatres) at the Ecole Centrale de Lyon (Graduate School of Lyon).

Keywords
assessment, interactivity, large class, virtual classroom

1 Context and goals

Lecturing to a large class is widely used as a teaching method in higher education, but is also known to present some difficulties (Gibbs and Jenkins 1992) – for example, lack of teacher–student exchanges, limited feedback, unmotivated students. Indeed, teachers are often challenged by having to perform a lecture and at the same time, wondering about the students' level of understanding. The teacher needs to devote a part of his or her attention and concentration to analysing the students' behaviour and encouraging them to participate. On the student side, lectures are sometimes perceived as boring and participation is complicated by shyness and fear of looking ridiculous in front of teachers or fellow students.

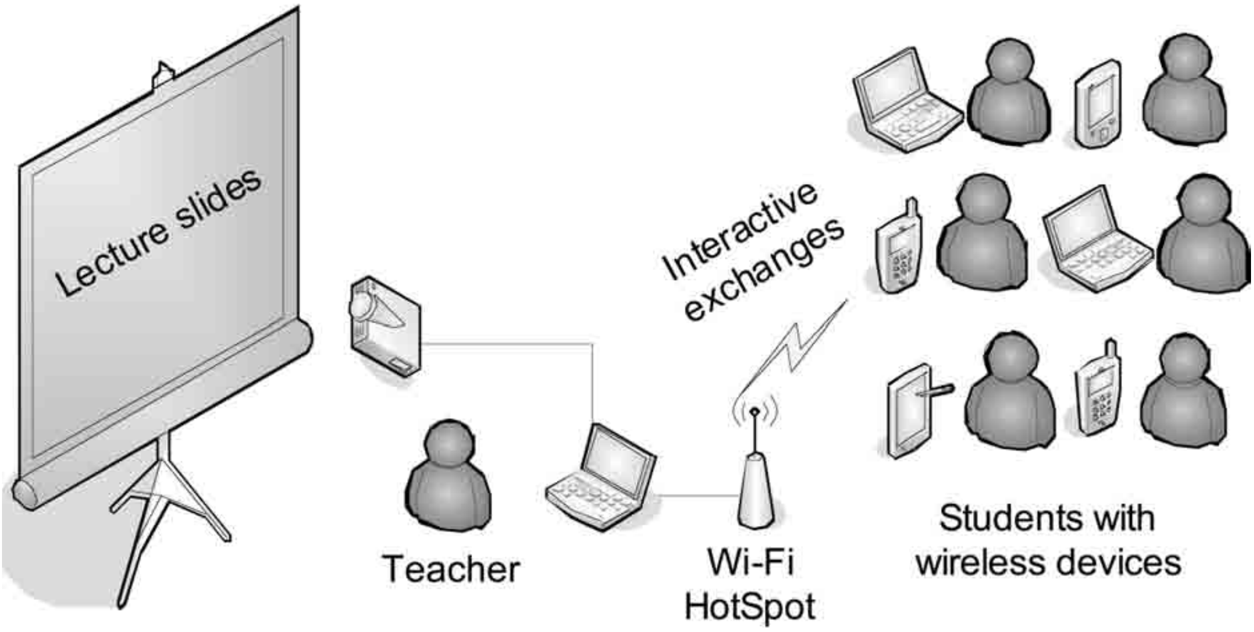
Over the past few years, e-learning has hugely increased the use of technologies in the educational arena, providing software solutions to manage remotely located students through the use of learning platforms or virtual classrooms. At the same time, very little has been done really to integrate the use of technologies into face-to-face lectures.

But since the rise of wireless networks and mobile devices, all the components are now available to build solutions that could help teachers to increase participation and get more feedback from students in lectures presented to a large class (VanDeGrift *et al*. 2002; Truong *et al*. 2002). This is the topic of our research programme at the ICTT research laboratory at the Ecole Centrale de Lyon where we are working on the DRIM–AP project (French acronym for Multiple Interactive Radio Devices and Participative Lecture Theatres; see David *et al*. 2004), the aim of which is to provide a software solution to aid teacher–student interactivity, based on the use of wireless devices and wireless (Wi-Fi) local networks.

2 The principle of an interactive large class using wireless devices

Mobile campus and student laptop equipment policies actually provide a favourable background for new wireless applications (localisation, IP phoning, etc). In teaching activities, like large-scale lectures, students can use their wireless devices to communicate in real time with the teacher, send him or her feedback, ask questions or answer in polls. The teacher projects the lecture slides as usual, but is also able to monitor the class with the same laptop computer in order to identify quickly the problems that the students are encountering. This allows the teacher to adapt the lecture; for example, giving further explanation about a concept misunderstood by the class. **Figure 1** (overleaf) shows an overview of the interactive large class based on a wireless network.

Figure 1 Principle of an interactive large class using wireless devices



3 DRIM–AP project

The DRIM–AP project is managed by ICTT, a multidisciplinary research laboratory working on the human and software aspects of cooperative interaction at the Ecole Centrale de Lyon. The DRIM–AP project is part of a Mobile Campus research programme, and is funded by an HP Mobile Technologies for Teaching Grant. Our aim is to design a tool based on interactive cooperation and wireless technologies for use in a face-to-face approach to teaching and to evaluate the usability of this kind of tool for students as well as for teachers. After a state-of-the-art overview realised last year, we have developed a software application and have also written an evaluation protocol in order to validate our work.

4 Functionalities

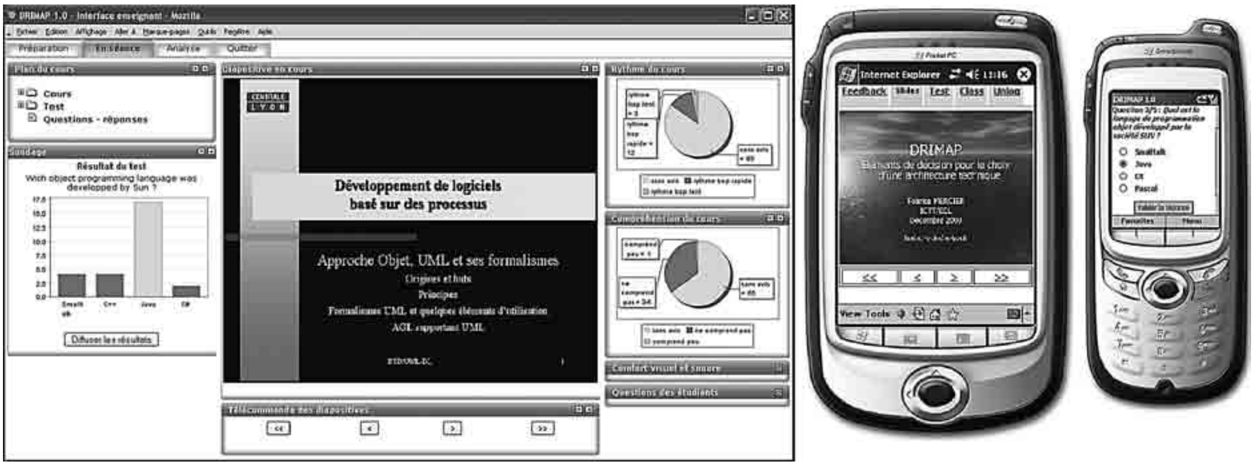
On the functional level, our solution brings together the main up-to-date techniques to realise interactive tests, students' feedback, questions to the teacher, notes. We have added complementary features improving monitoring tools for the teacher, slide display control and event tracking. With DRIM–AP, students can give feedback to the teacher about the lecture, on topics such as pace (too slow, too fast), understanding, sound and visual ambiance. They can also write and submit questions or remarks, take notes, give answers to full assessments or quick polls. On his/her side, the teacher manages the interactive class, submits tests and polls, receives and reads students' messages on his or her laptop computer. All events (question, feedback, slide display) are tracked by DRIM–AP. The lecture can then be replayed by the teacher in order to identify where the main problems (eg understanding, lecture speed) occurred.

5 Technical aspects

The DRIM–AP application software is based on the Java 2 Platform, Enterprise Edition (J2EE) and is hosted by an open source application server. A standard web-based thin client is used on purpose to make the deployment easier, but applets can be used as well when needed. So the application does not need to be installed on the user device, but can be directly accessed on a web server.

A web-based collaborative portal framework forms the core of the DRIM–AP software. It was built to support multiple wireless devices (eg PDA, laptop, Tablet PC, Smartphones). The user device type is detected at its connection to the web server and the user interface (UI) is dynamically built with portlet components (JCP 2003) that are reorganised according to the screen resolution and display capabilities of the mobile device; for example, HyperText Markup Language (HTML) or Wireless Application Protocol (WAP).
In terms of data representation, DRIM–AP integrates Extensible Markup Language (XML) specifications based on IMS Learning Design (IMS–LD; see IMS 2003) to describe the lecture activities and the learning objects (chapters, slides, tests, support activities). IMS Question and Test Interoperability (IMS–QTI; see IMS 2000) is also used for the XML description of assessments so that an authoring tool can be used to create the tests and the questions.

Figure 2 Screenshots of the DRIM–AP user interface (UI) on several devices



6 Evaluation

One major purpose of our study is to evaluate the usability of wireless interactivity in a large class from the teacher's and the students' point of view. For the teacher, we wish to establish that the monitoring activity and all the information displayed on the screen are not creating a cognitive overload that could disturb him or her during the lecture. For the student, it seems important to know if this approach is suitable for learning in all knowledge domains or only for some. The project's main goal is to establish whether the use of wireless technologies contributes to improve the learning process in lectures presented to a large class, or if it is just another 'technological gadget'.

7 Conclusion and future works

From a technical point of view, we have proved in our work that existing wireless technologies are suitable to bring interactivity into lectures presented to large classes. We now have to evaluate the cognitive impact and usability of such a system during teaching activities. To achieve this, an evaluation programme with teachers and students of the Ecole Centrale de Lyon will start in the autumn of 2004. The next step will be to release a version of the DRIM–AP software that we would like to make available to the education community.

References

David B, Mercier F, Chalon R, Delotte O and Berthet JP (2004). AMPHI INTERACTIF: état de l'art et projet DRIM–AP. In *Actes des Premières Journées Francophones: Mobilité et Ubiquité, 1–3 juin, Nice–Sophia–Antipolis*, France. New York: ACM, 21–24.

Gibbs G and Jenkins A (1992). *Teaching in large classes in higher education, how to maintain quality with reduced resources*. London: Kogan Page.

IMS (2000). *IMS Question and Test Interoperability: best practice and implementation guide. Final specification version 1.01*. Burlington, MA: IMS Global Learning Consortium.

IMS (2003). *IMS Learning Design: best practice and implementation guide. Version 1.0 final specification*. Burlington, MA: IMS Global Learning Consortium

JCP (2003). *JSR 168: portlet specification*. At www.jcp.org/jsr/detail/168.jsp

Truong TM, Griswold WG, Ratto M and Star SL (2002). *The ActiveClass project: experiments in encouraging classroom participation*. Technical Report CS2002–0715. San Diego: University of California at San Diego.

VanDeGrift T, Wolfman SA, Yasuhara K and Anderson RJ (2002). *Promoting interaction in large classes with a computer-mediated feedback system*. Technical Report 02–12–02. Seattle: Computer Science and Engineering Department, University of Washington.

mLab: handheld assisted laboratory

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Abstract

This paper explores the potential of an m-learning environment by introducing the concept of mLab, a remote laboratory environment accessible through the use of handheld devices.

We are aiming to enhance the existing e-learning platform and internet-assisted laboratory settings, where students are offered in-depth tutoring, by providing compact tuition and tools for controlling simulations that are made available to learners via handheld devices. In this way, students are empowered by having access to their simulations from any place and at any time.

Keywords
blended learning, m-learning, remote laboratory

1 Introduction

The recognition of the role that mobile devices are likely to play in the future of learning (Keegan 2002) has led us to seek for learning materials and feasible applications for mobile devices in higher education. To the best of our knowledge, there has not been any similar initiative, offering remote laboratory access over the mobile device.

The starting point for this project was the Guided Wave Theory engineering course at our university, which consists of learning sessions that involve a blend of technologies. The course content material is presented via traditional classroom lectures and an interactive online learning environment. Additionally, a vital part of this lecture course is the remote, online laboratory setting (iSign), a self-learning environment where students can practise transferring theoretical knowledge into practical experiments (Christ 2002) in the area of electromagnetic fields calculation.

Since the launch of the iSign online laboratory in September 2001, experience has shown that the students are very motivated to use this blended approach that allows them to organise and pace their learning in the way that best suits their preferences and goals.

The use of mobile devices within iSign started with Short Message System (SMS) notification on the successful completion of the simulation. During the last few years, we have witnessed the rapid development of wireless technologies and mobile devices, as well as the release of new and powerful Java technology for creating applications for mobile devices – Java 2 Platform, Micro Edition (J2ME). All this made the concept of the handheld-assisted laboratory model a feasible project.

2 mLab: the handheld-assisted laboratory model

The input and display capabilities of wireless devices are cumbersome and limited. Consequently, the learning content for those devices needs to be carefully designed and selected. Furthermore, these very restrictions can be exploited to give the learner easier access to the most important and relevant learning material (Li 2003).

In our project, learning content within the mLab application is designed to be a brief summary of the classroom course with a focus on necessary instructions and formulae to accomplish the laboratory tasks. In addition, the students are able to test their knowledge with the multiple-choice questionnaire.

Using a wireless device, the student can log in to the remote server where the simulation is carried out, and start and stop the simulation. The simulation run can take anything from several minutes to several hours. During this time, the student is able to check the progress of the simulation via the mobile device. Finally, the student is provided with the evaluation of his or her results, where they are compared with the reference results set by the teacher.

The overall structure is presented in **Figure 1**. The web- and mobile-based applications are completely developed in Java. Use of the same technology, both on the client and the server side, simplifies infrastructure integration and allows the use of existing knowledge, tools and code through the network (Mitic 2003).

The iSign platform is the application server that provides access for different types of client through different connectors. It connects to the database where all user settings and simulation data are stored. The simulation server deploys the actual software for the electromagnetic fields calculation.

The mLab application is not a stand-alone application; it provides a limited learning material and simulation functionality compared to a web application. Therefore, the use of a web-based and mobile-based laboratory is seen to be complementary, in the way that it provides unconstrained and continuous access to the laboratory settings.

3 Current state of play and further work

In the current stage of the project, we are implementing the application to be used by students on the Guided Wave Theory course in order to evaluate their motivation and expectation when using the mLab platform. The application has been tested on different devices to assure portability and the same 'look and feel'. The plan is to make it available to students from the winter semester of 2004. We expect to get valuable knowledge that will help us to improve the mobile learning content and the student experience. The goal is to offer students an efficient and innovative laboratory environment that is accessible at any time and from any place.

References

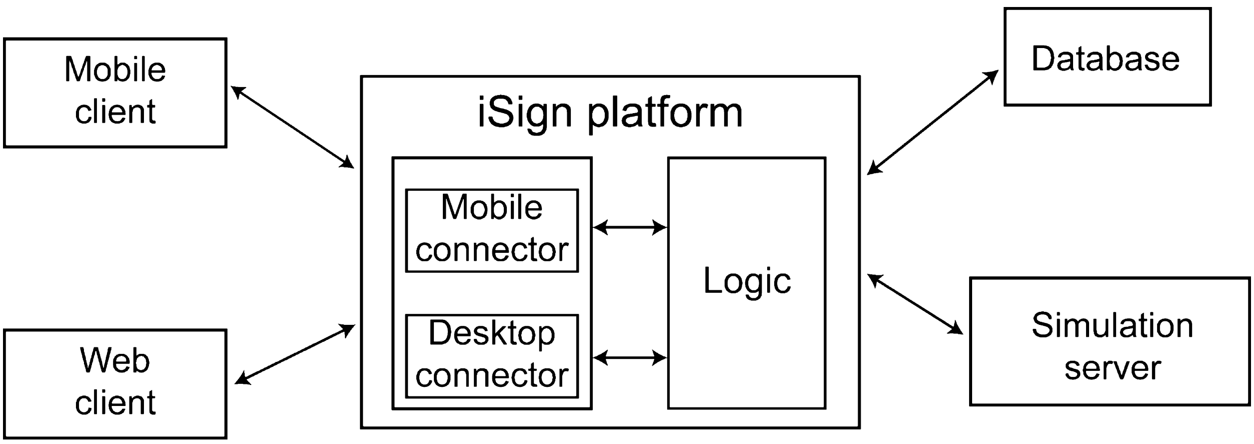
Christ A (2002). *Client-server architecture for* [the] *Active-Online-Learning Laboratory*. Paper presented at the Online Educa 8th International Conference on Technology Supported Learning and Training, Berlin.

Keegan D (2002). *The future of learning: from eLearning to mLearning*. ZIFF Papiere 119. Hagen: FernUniversität. At http://learning.ericsson.net/mlearning2/project_one/book.html, accessed 13 September 2005.

Li M (2003). Practice related e-learning – the VIP framework. In *Proceedings of the 9th International Conference of European University Information Systems, Amsterdam, 3–4 July*.

Mitic J (2003). *Developing wireless application for simulation control*. Master's thesis: University of Applied Sciences Offenburg.

Figure 1 Overall architecture of the web-based and mobile learning platform



Collaborative m-learning using agents and virtual reality

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Abstract

The delivery of learning material on mobile devices, termed m-learning, has aroused great interest in the research community of late. This paper describes a collaboration between the CLEV–R and ABITS projects to provide an e-learning system that can be adapted for use on mobile platforms. The Collaborative Learning Environment with Virtual Reality (CLEV–R) is a web-based multi-user environment that enhances a student's learning experience through the use of Virtual Reality (VR) and multimedia. It provides a social setting for collaborative learning where users, represented by avatars, take on roles in the virtual world. The Agent-Based Intelligent Tutoring System (ABITS) enhances existing online tutoring mechanisms within a higher education institution (HEI) by delivering course material tailored to a user's preferences, knowledge and learning style. This paper gives an outline of the e-learning environments and focuses on the methods to be used to present it on a mobile platform.

Keywords
e-learning, m-learning, intelligent agents, virtual campus

1 Introduction

The use of handheld computers such as personal digital assistants (PDAs) has increased in recent years in a wide variety of contexts. This increase has been fuelled by the convenience of mobile devices along with improved computing power and affordability. The use of PDAs enables people to perform tasks while on the move, making the PDA the ideal travel companion. One rapidly developing area in research at present is m-learning, where traditional e-learning systems are extended to mobile platforms. E-learning can provide those who cannot attend a traditional university with a wide variety of learning resources and expertise that would otherwise be unavailable to them. These services provided on a mobile platform therefore allow people to learn and access course material 'anytime, anywhere'. M-learning can be used for distance learning, but can also be used to accompany traditional teaching methods within universities.

The Collaborative Learning Environment with Virtual Reality (CLEV–R) project, (McArdle *et al.*) and the Agent-Based Intelligent Tutoring System (ABITS) (Roche and Mangina 2003) both provide a system for online learning. At present, they have been developed for use within University College Dublin (UCD) to deliver online course material to the undergraduate student population. ABITS utilises agent-based technology to assist students and provide a personalised tutoring system based on a student's personal needs, preferences and learning style. CLEV–R provides a new way for students to learn, collaborate and socialise online. The use of VR in the educational domain, bringing a social aspect to learning, is a novel idea in the area of e-learning. Together, CLEV–R and ABITS will provide a personalised VR learning environment augmented and managed by intelligent agents. Students, tutors and courses are represented using the belief–desire–intention (BDI) agent paradigm in ABITS; and course content is delivered using the VR environment of CLEV–R. This paper describes the collaboration between CLEV–R and ABITS, with a particular focus on their future extension for use on mobile devices such as PDAs.

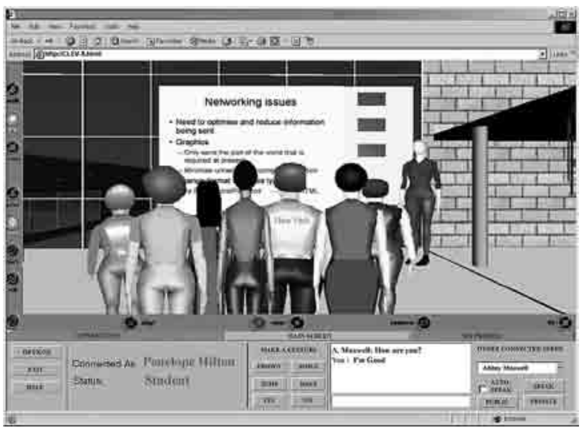
The rest of this paper is organised as follows. In section 2, an overview of both ABITS and CLEV–R is provided. Section 3 gives details of how the combined system can be adapted for use on mobile devices, while section 4 discusses further development and gives some results of initial testing.

2 Overview

2.1 CLEV–R

The CLEV–R system is a web-based multi-user VR environment that supports interactive e-learning for university students through the use of several different types of multimedia. In addition to providing an immersive environment where users are represented by avatars (3Name3D 1997), active learning is supported through intuitive interaction with tutors and fellow students. Natural methods of communication such as voice and text chat are available and users may also direct their avatars to make gestures. Synchronous learning is available in the form of lectures, tutorials and meetings where multiple users are connected simultaneously. Self-paced asynchronous learning is also provided and consists of students downloading and reviewing course material. The synchronous aspect lends itself very easily to student collaboration on group projects. The VR environment mimics a university setting, offering many of the services available on a real college campus. For example, lecture rooms and group meeting rooms are provided to assist the students' learning. These rooms are augmented with shared whiteboards and presentation boards for delivery of learning content. Multimedia facilities, such as audio and video, can also be presented in these rooms if required. Tackling the social needs of students is one of the primary objectives of CLEV–R. To achieve this, informal settings have been developed where students can discuss course content. This removes the feeling of isolation, which has often been an issue in conventional online learning applications. **Figure 1** depicts the CLEV–R user interface (UI).

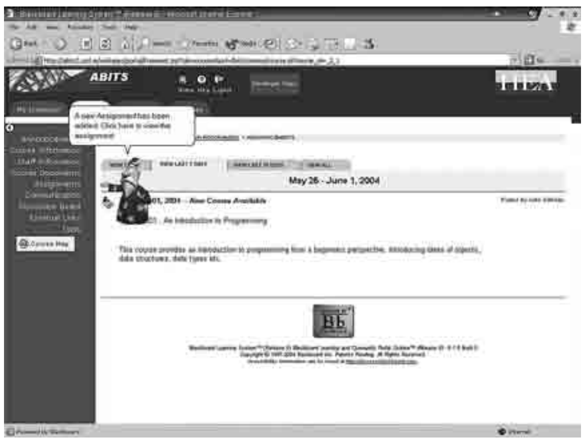
Figure 1
The CLEV–R user interface



2.2 ABITS

ABITS attempts to supplement the existing classroom and lecture-based teaching system used within UCD, while also providing the ability to run courses solely in an online environment. ABITS can be used to deliver courses online, including assignments, assessments and tests. A multi-agent system (MAS), based on the BDI model, provides the ability to reason about student learning abilities and goals. An intelligent agent's beliefs represent its current knowledge, which includes any type of information about its environment at a particular time. This information includes details of courses and materials studied by the students, supplemented with details of learning styles and preferences for media type and content granularity. The content of its belief set guides the agent's behaviour and therefore the information selected for presentation to students. **Figure 2** depicts the interface for ABITS.

Figure 2
The ABITS interface



3 The mobile application

Since m-learning has been receiving much attention in the research community recently, the extension of both CLEV–R and ABITS for use on mobile devices seems like a natural progression. It is beneficial for students to be able to learn while on the move. Due to both the limited memory and screen size of mobile devices, content will be altered to ensure it is delivered in an efficient manner to the users. The Graphical User Interface (GUI) will also need to be adapted.

A much simpler view of the GUI will be presented to a mobile user. The virtual campus is being developed using Virtual Reality Modelling Language (VRML 1997); support for this is presently available for PDAs in the form of Pocket Cortona by ParallelGraphics (ParallelGraphics 2004).

This is a VRML plug-in that works in conjunction with Pocket Internet Explorer. It proves quite effective for displaying small files (up to 20kb); however, larger files are very slow both to download and render. Consequently, we intend to reduce the amount of the VRML world that will be displayed on the mobile devices. Many different techniques are currently being explored to achieve this – techniques include culling algorithms such as view frustum culling, backface culling and occlusion culling (Martens 2003) and Levels of Detail (LOD; see Ames, Nadeau and Moreland 1996). These methods limit the amount of the VRML world that is rendered and also the number of animations that occur, and so improve the overall efficiency of the system.

ABITS is being developed to include an intelligent user interface (UI) which can adapt, based on a number of criteria including available bandwidth, device type, user preferences, etc. This adaptation is achieved by exploiting technologies such as Extensible Markup Language (XML), Extensible Stylesheet Language Transformations (XSLT) and JavaServer Pages (JSPs) to separate content and deal with layout concerns. On mobile devices such as PDAs, restrictions are enforced so that ABITS makes available only the content and options that can be displayed and performed given resolution and processing restrictions.

4 Results and further development

An initial implementation of CLEV–R has been developed for desktop computers. A VR university setting is provided and has been networked so that multiple users can connect to the system. A GUI has been designed, and users, represented by avatars, can browse presentation and notice boards. Initial feedback from a set of test users has proved encouraging. An initial prototype of ABITS has also been developed and testing is due to commence in the near future. At present, the VR component of CLEV–R has been successfully tested on PDAs and further work is now being carried out to improve its display and performance. An interface for the ABITS system has also been developed for mobile devices.

References

Ames AL, Nadeau DR and Moreland JL (1996). *Vrml 2.0 sourcebook*. New York: John Wiley and Sons.

Martens R (2003). *Occlusion culling for the real-time display of complex 3D models*. Master's thesis: Transnational Universiteit Limburg, Germany.

McArdle G, Monahan T, Bertolotto M and Mangina E (forthcoming). A web-based multimedia virtual reality environment for e-learning. In *Proceedings of Eurographics '04*. Short presentations and interactive demos section, Grenoble, France, August 2004, 9–13.

ParallelGraphics (2004). *The Pocket Cortona*. At www.parallelgraphics.com/products/cortonace/, accessed April 2004.

Roche B and Mangina E (2003). Agent-based framework for intelligent tutoring systems within University College Dublin. In *Proceedings of the International Conference on Information Communication Technologies in Education, Samos, Greece, July 2003*.

3Name3D (1997). *Animation created by Cindy Ballreich (c) 1997*. At www.ballreich.net/vrml/h-anim/nancy_h-anim.wrl, accessed April 2004.

VRML (1997). *VRML 97 specification*. At http://tecfa.unige.ch/guides/vrml/vrml97/spec/, accessed April 2004.

A new model for the m-learning emergency scenario in risk contexts: the emergency operator

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Abstract

The m-learning emergency system (mLES) is a model developed by ENEA (the Italian National Agency for New Technologies, Energy and the Environment) to support management of emergencies through m-learning. The model provides system-comprehensible representations and user-navigable access. The content needs to be developed using representations that separate content from format for flexible delivery, independent of the device used.

At the next level, we need to add to that content model an architecture that provides knowledge of the user and their context, as well as knowledge of the content available, to provide the right match. This requires a user categorisation scheme and a mapping process to create an intelligent delivery environment. The mLES provides also for the training of a new type of professional – emergency operators who function as intermediaries between the people personally experiencing the high-risk or emergency situation and the m-learning-based technological system. The mLES can become an important asset for the community, with positive implications in the security and social domains, representing a valid tool for those who already work in emergency management in the different operational centres in the field.

Keywords
m-learning, emergency, scientific knowledge

1 Introduction

The coming of TIC (Training for Industry and Commerce) in the modern economy and the diffusion of the internet at a global level have brought about a revolution also in methods of training, introducing a new educational philosophy – e-learning. The rising importance of e-learning was acknowledged also by the European Commission (EC) when it adopted in May 2000 its eLearning Action Plan, which launched an initiative aiming to redraw the way to deliver education in Europe, supporting training processes that use new multimedia technologies and the internet to improve learning quality.

The use of information and communication technologies (ICT) in education and training has undergone several paradigm shifts over the last three decades. The concepts of e-learning (learning supported by digital 'electronic' tools and media) and m-learning (e-learning using mobile devices and wireless transmission) have only emerged very recently. Handheld devices are emerging as one of the most promising technologies for supporting learning and particularly collaborative learning scenarios, mainly because they offer new opportunities for individuals who require mobile computer solutions that other devices cannot provide. During the last few years, mobile technology has become integrated into day-to-day activities. Handheld computers appear to be part of a general movement towards mobile technology.

The convergence of computing and communication is a process that is about to turn phones and mobile terminals into powerful multimedia units. For example, Synchronised Multimedia Integration Language (SMIL), which is based on Extensible Markup Language (XML), has been devised for the distribution of sophisticated multimedia content. These forms of interactive multimedia offer new possibilities for how we learn, think and communicate.

Mobile learning can be defined as '…any service or facility that supplies a learner with general electronic information and educational content that aids in acquisition of knowledge regardless of location and time…' (Lehner and Nosekabel 2002). Technologically, we can now define mobile learning as e-learning's new frontier, and according to a study by Adkins (2003), by 2006, the m-learning market will be worth more than 5bn US dollars. The enormous potential of m-learning is ensured by the rising development of the wireless and mobile telephone market.

According to recent research on mobile telephony by Intex Management Services (IMS), from sales of 288m mobile phones in 1999, we will reach sales of 1bn items in 2004. The growth of this market is predicted to reach 1.34bn mobile phones in 2006, when there will be 1.79bn users throughout the world.

2 The mlearning emergency system (mLES) project

ENEA, the Italian National Agency for New Technologies, Energy and the Environment (Ente per le Nuove Tecnologie, l'Energia e l'Ambiente), has been engaged for a long time in handling processes of knowledge transfer to enterprises and schools, as demonstrated by various technological transfer initiatives realised at a local level, and by many collaborations with schools of all kinds. ENEA has always promoted the diffusion and transfer of its own research results, supporting and favouring the technological innovation processes of small and medium enterprises (SMEs).

Precisely because of the importance, for a Learning Economy, of training in technological transfer processes, ENEA developed an e-learning platform to make sure that knowledge and capabilities generated within the agency would be transferred through training to the highest possible number of individuals, and particularly to those working in SMEs.

ENEA's e-learning platform was launched in 1996; the project was devoted to the continuing education and retraining of workers. After this successful experience, the mission of the ENEA e-learning platform became the promotion of sustainable development through the diffusion of scientific culture and technological transfer to any person – not just workers, but also students and unemployed people. Now there are more than 12,000 users and 30 courses online, with the number of courses expected to double in 2004.

Some of the courses will be translated into other languages to allow other Mediterranean countries to use the ENEA e-learning platform. Many agreements with schools, universities and private and public training organisations are under way. The purpose of these agreements is to build up an open database of scientific learning objects that anyone can use.

The online training philosophy that ENEA adopted is dictated by the needs of the end users who, being strongly motivated to learn, are asking for an absolutely unrestricted training, in terms of time as well as methods. ENEA offers a system that can be considered as self-training for its own users, so that the learners will be free to learn what they want, when they want and where they want. From a pedagogic perspective, mobile learning supports a new dimension in the educational process. The ENEA educational process and philosophy are very close to the m-learning educational philosophy – that mobile learning systems should be capable of delivering education content at any time and anywhere the learners need it.

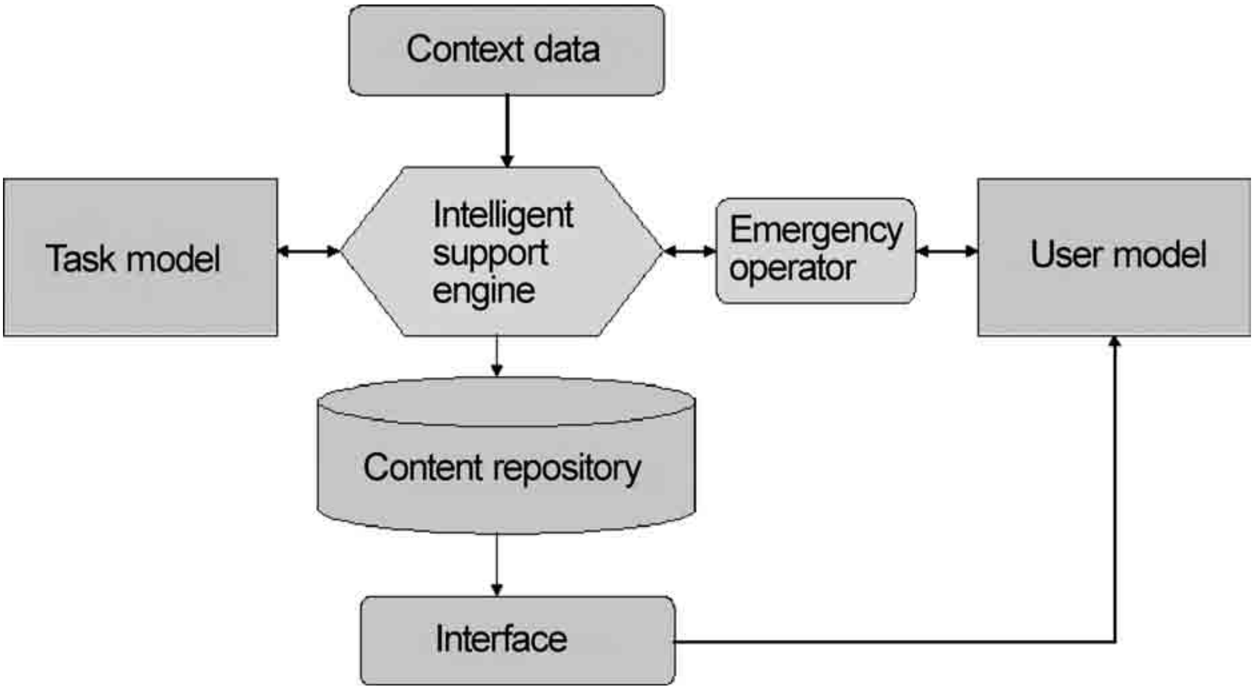
Emergency m-learning is one of the possible applications of m-learning, offering the possibility of exploiting the m-learning characteristics for learning processes in emergency cases.

An emergency is a situation that can produce risks, precisely because it is different from the events that are normally experienced by workers or the general public. The ENEA project's idea is to create a technological system that ensures, through mobile learning, the management of emergency cases.

To execute this vision, we start with a content model that provides system-comprehensible representations and user-navigable access.

At the next level, we need to add to that content model an architecture that provides knowledge of the user and their context, as well as knowledge of the content available, to provide the right match. This requires a user categorisation scheme and a mapping process to create an intelligent delivery environment. **Figure 1** (opposite) depicts the architecture of ENEA's mLES system.

Figure 1 Architecture of ENEA's m-learning emergency system (mLES)



Knowing how to manage emergencies means not only knowing the procedures and technical aspects needed to limit such risks, but also knowing how to be effective communicators and how to control the emotional situations that can surface. To be an effective communicator in emergency situations calls for attitudes and capabilities different from those needed in ordinary communication: authoritativeness, emotional strength, the capacity to adjust, etc.

The mLES, then, provides for the training of new professional figures – emergency operators who function as intermediaries between the people personally experiencing the emergency or high-risk situation and the m-learning-based technological system.

So, in the case of an emergency, the subject at risk contacts the emergency operator through a mobile device (mobile phone, palm computer, etc) and the emergency operator uses mLES to extrapolate the emergency learning object that represents the most appropriate solution, and then forwards it, via the mobile system, to the person at risk.

The emergency operator is a key figure, since as well as knowing how to interpret and to manage emergency calls, he or she must also be capable of managing the possible panic of the person at risk. To ensure that the system will be efficient, we must obviously have an articulate content repository containing all the examples of likely emergency events and the respective emergency learning objects with which to respond to the various help and emergency calls.

3 Conclusion

In Italy, the use of mobile phones to report an emergency has a yearly traffic of 33m calls. This data allows us to claim that an emergency m-learning system can become an important asset in Italian life, with positive effects in the security and social sectors. It represents a valid tool to support those who already work in emergency management in different local operation centres; for example, law enforcement agencies, public service agencies, local emergency services, health centres, schools and civil protection organisations.

In 2004, ENEA designed and created an innovative platform called MATRIX 3, which includes videoconference functionality for online classes and seminars, using Active Server Pages (ASP), web-based and Real technologies.

Furthermore, the ENEA Usability Lab tested advanced visual interfaces to interrogate databases and to search on the Web in Java language. In this context, it was decided to proceed with Java-realised modules, and to pass later to a full Java platform for use on intranets as well as the internet. The outcome of this strategy was the implementation of mLES with its modules JNetseminar and JNetLesson, which aims to combine the functionality of web-based modules with other more innovative and complete functionalities.

Thanks to its experience in the e-learning sector and in research on advanced computer systems supporting training and video communication, ENEA is ready for this challenge in the mobile learning field, and is open to agreements and collaborations aimed at making an m-learning emergency system a well-established reality at the service of the local community.

References and further reading

Adkins SS (2003). *Market analysis of the 2002 US e-learning industry*. Available via brandon-hall.com

Kinshuk (2003). *Adaptive mobile learning technologies*. Palmerston North: Department of Information Systems, Massey University.

Lehner F and Nosekabel H (2002). The role of mobile devices in elearning – first experience with [the] elearning environment. In M Milrad, HU Hoppe and Kinshuk (eds) *Proceedings of the IEEE International Workshop on Wireless and Mobile Technologies in Education*. Los Alamitos, CA: IEEE Computer Society.

Quinn C (2002). Flexible learning: mobile learning objects. White paper. Bellevue, WA: *Knowledge Anywhere*. Available via www.knowledgeanywhere.com

Vavoula GN and Sharples M (2002). KleOS: a personal, mobile, knowledge and learning organisation system. In M Milrad, HU Hoppe and Kinshuk (eds) *Proceedings of the IEEE International Workshop on Wireless and Mobile Technologies in Education*. Los Alamitos, CA: IEEE Computer Society.

MOBIlearn user trials on the museum scenario: the first results of preparatory work

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Abstract

The MOBIlearn project, co-funded by the European Commission (EC), the US National Science Foundation (NSF) and the Australian Department of Education, Science and Training in July 2002, is strategically positioned to provide relevant research outcomes in the area of innovative use of mobile environments to meet the needs of learners, both working by themselves and with others. During the project, we had to find ways of harnessing all the available expertise to feed into this vision of the future, and scenarios for 'envisionment' are an effective means to achieve this. The paper introduces the MOBIlearn museum scenario and the results of the preparatory work before the final user trial.

Keywords
m-learning, user scenarios, mobile learning architecture, user trials, evaluation planning

1 Introduction

The integration of new technologies in education and training is in essence a culturally driven process, with the need to bring about change not only in people, but in the entire learning environment. In recent decades, political and social progress has emphasised the need for free circulation of knowledge, as the most advanced answer to the increasing need for new skills related to new technologies and new socio-economic models created by the information society.

The e-Mobility 2001 EU–Information Society Conference on Mobility in the Knowledge Economy held in Göteborg, highlighted the priorities that should be explored – the need to define new work paradigms (eg mobile worker) together with innovative models for their social, economic, cultural and environmental deployment, while preserving the local nature of content (national and regional) and cultural heritage.

At the same event, it emerged that the sustainable social and economic deployment of such models within the information society of the third millennium will see new technologies for mobile access to knowledge taking a key role.

On these social and technological premises, the MOBIlearn project (Da Bormida *et al*. 2002) aims to improve access to knowledge for selected target users, giving them ubiquitous access to appropriate, contextualised and personalised learning objects, by linking to the internet via mobile connections and devices, according to innovative paradigms and interfaces.

The Göteborg Conference also underlined the need for pilot experimentations and technological applications to ensure the fast spread and uptake of planned models and related services in order to preserve Europe's leadership in the exploitation and creation of new mobile technologies. The need for this is becoming urgent. Thus, the MOBIlearn project is justified in two ways: its pioneering research and development (R&D) directly targets priority areas for the information society; and its exploitation directly addresses the need for Europe to stay dominant in the important area of mobile applications.

The project includes studies of conceptual models and new methodologies, with prototypes to implement them. These will be evaluated in trial application fields set up and managed by international partners participating within the MOBIlearn project. The objective is to improve the knowledge level of individuals by optimising the cost and time of learning processes. This maximises the opportunities of three representative groups (Taylor *et al*. 2002):

- workers – to meet their job requirements and to update their knowledge continually
- citizens as members of a culture – to improve their learning experience while visiting a cultural city and its museums
- citizens as family members – to have simple medical information for everyday needs.

2 Scenario definition and function

The function of scenarios in this context is to set the scope of user goals, to explain to other people about possible activities in the mobile learning domain, and for others to explain to us what they envisage. Various methods can be used to generate scenarios for this purpose, including storyboards, video clips, diagrams, textual stories and so on.

Scenarios (Taylor *et al*. 2002) are tools for ordering one's perceptions about alternative future environments in which today's decisions might be played out. In practice, scenarios resemble a set of stories, written or spoken, built around carefully constructed plots. Stories are an old way of organising knowledge; when used as strategic tools, they confront denial by encouraging – in fact, requiring – the willing suspension of disbelief. Stories can express multiple perspectives on complex events; scenarios give meaning to these events.

Scenario planning is a method for learning about the future by understanding the nature and impact of the most uncertain and highly influential forces that will affect it. So far, the scenarios we have produced have been developed by a relatively small subset of the partners associated with MOBIlearn.

At the first MOBILearn meeting, we agreed a working definition of 'scenario' as follows:

Workpackage 2 scenarios will be constructed at an appropriate level of detail which will be quite high. They will contain a narrative, describing a situation where a user is engaged in a task. The scenario will be relatively informal, and have the character of a true story. Scenarios will be created by members of WP2 (in the first instance). We will invite other members of the MOBIlearn project to contribute scenarios.

These scenarios will form the basis of the first engagement with users and stakeholders. Users and stakeholders will also be asked to construct their own scenarios.

The function of scenarios is to set the scope of user goals, to explain to other people about activities within the mobile learning domain, and for others to explain to us what they want. Various methods can be used to generate scenarios, including storyboards, video clips, diagrams, textual stories etc.

(MOBIlearn WP2 2002)

3 Developing the museum scenario

Museums are the means whereby we research, interpret and present our insights into the natural and cultural worlds. They represent our belief systems concerning cultural interrelationships, our relationship with the environment and our place in the universe. They give each person a space in which to dream.

Wireless technology is becoming a part of the museum experience. In an effort to bring art and science to life for a new generation of technically sophisticated patrons, an increasing number of museums are experimenting with advanced mobile technologies to make going to museums more interactive, more educational – and more fun.

Newly emerging portable device and wireless network technologies have the potential to enhance significantly the experience of a museum visit. On the exhibit floor, visitors carrying wirelessly connected devices can be given opportunities for exploration, sharing, explanations, context, background, analytical tools and suggestions for related experiences.

In addition, conventional desktop and internet technologies can help to extend the visit – both in advance, through activities that orient visitors; and afterwards, through opportunities to reflect on and explore related ideas. In the following section, we give some examples of projects that have been undertaken in this area.

The San Francisco Museum of Modern Art (SF MOMA) launched 'Points of departure: connecting with contemporary art', an experimental programme that offers visitors handheld devices connected to a wireless network to provide them with video clips about works on display. 'In many cases, you have the actual artist telling you about the work you're looking at,' said Peter Samis, Program Manager for Interactive Educational Technologies at the museum. Using handheld devices such as HP iPAQ Pocket PCs, visitors will use the beacons to tap into web-based information about an exhibit while at the museum, or access the content later on from their home or school PC. 'For us, it's not just about enhancing the experience during the visit,' said Dr Robert Semper, the museum's executive associate director. 'It's also about offering content that extends learning beyond the museum's walls by giving you access to information about activities or experiments you can try on your own at home or at school.'
Of course, building the infrastructure to support such a system is a massive endeavour.

'The interface, content and devices have all got to work seamlessly in a way that enhances the visitor experience and brings value,' said Mirjana Spasojevic, a project manager at HP Labs. 'It's about bringing pervasive computing out of the lab into the real world.'

As early case studies, museums will help to answer questions that will shape the future of pervasive or ubiquitous computing. 'We're going to learn what types of device people want to use, what kinds of graphical interfaces they like, what content they prefer – text, audio, visual – and how they like to use these devices without feeling like a bunch of cyborgs,' said SF MOMA's Samis. HP iPAQ Pocket PCs are in use in museums – 'It's the way of the future'.

Wireless is a great way to give visitors access to content that provides context to exhibitions. 'Another key will be finding out how these technologies impact [on] informal learning,' said Spasojevic. 'We're finding that kids adapt very well to the technologies, while older people tend to want to share the devices and discover things together.' For the museums themselves, the challenges of mobility are not limited to the technology. HP and the Exploratorium in San Francisco (a children's science museum) launched a large-scale test of wireless technologies with around 100 participants, to develop models and methodologies for studying users in mobile computing environments and then report their findings to the museum and technology communities.

'There's no telling what we'll learn,' says Spasojevic. Yet those involved with implementations at other museums have their own thoughts. 'The first thing you learn is [that] the technology changes so fast that you shouldn't expect your first implementation to be the final solution,' said Samis. 'All experiments are good, but they're really just grist for the mill.'

3.1 Requirements in the museum setting

Considering that we are going to create a mobile system in a museum, our system design started with the following assumptions.

- The system users are a diverse group, covering a large range of ages, levels of scientific sophistication and familiarity with computers and handheld devices. We would like to provide personalisation and user control of the information and services through customisation at the level of an individual or of a group. The system should also support communication between visitors.
- The system needs to support both synchronous delivery of content to handhelds at the exhibit and asynchronous delivery for users who may not want to absorb a large amount of information on the spot, but prefer to 'bookmark' interesting artifacts and browse the web pages later.

There are issues as to how users can carry and use handheld devices, and how well the devices will survive in a somewhat hostile environment. The physical environment can be noisy and bustling. Many of the exhibits at the Exploratorium, for example, require physical action involving the whole body (eg spinning around on turntables or chasing balls across the exhibit area) and/or manipulation using both hands.

In addition, the specific requirements to create an appropriate m-learning system for museum experiences are the following:

- personal profile
- virtual contextualised maps
- useful information
- simple and complex queries search
- customised information according to users' preferences in terms of interaction modalities, delivery media and personal interest in specific topics
- the system must allow groups visiting the museum to stay in contact with each other remotely while maximising each member's museum experience
- control of traffic flow for the museum administrator
- display or exchange of content
- linguistic and contextualised supporting services
- the possibility of making notes and comments at every moment of the museum visit and on each painting seen.

How can these requirements fit into a scenario? You can imagine: you bring your own Wireless Application Protocol (WAP) device to the museum: it could be a Palm Pilot; it could be a mobile phone; it could be some combination of both things, since we seem to be moving in that direction. As you walk through the museum, because of the sensory technology that is embedded in the tombstone signage beside the pictures, or in the floor next to the pictures, your device knows where you are in the museum and it knows what you have looked at. The device builds a record of the objects you look at as you move around. At the end of that museum experience, or when you get home, you can look at the record and say 'Actually, I want more information on all of them'.

Your device finds the information and delivers it to the platform in your house that is most appropriate for you. I can imagine another scenario. The museum has a profile of you. One day you are passing the museum and your device calls you, saying, 'Hello. We have a great exhibit on Native Americans and we really think you would like it. Why don't you come in?' This technology beckons you into the museum. You can imagine, then, the rewards of being a regular patron: the museum knows you better and it knows both how to engage you and surprise you.

An ideal electronic guide to a museum is one that you take at the entrance, put in your pocket and forget you have. It should fully support a free, natural visit, providing the most appropriate information at the right time and place. The only activity required of visitors is to enjoy the exhibition: the interaction is with the (augmented) museum, no longer with the guide; the guide analyses the context and composes presentations adapted to the current situation. Of primary importance in an augmented museum is the interpretation of both visitors' behaviour (eg stops, long stay, coming back) and the context in which the action takes place. The places of use (a museum, the open air), the device (a PDA, a phone) or the available infrastructure [networks, Global Positioning System (GPS), infrared] are as important as social aspects (eg being alone or not, who the others are, if this brings pressure) and personal traits (eg attitudes, preferences, interests). This interpretation involves both material and social aspects.

Starting from these considerations, we have created a useful questionnaire and interviewed 600 visitors in museums in Florence and at the Duchy of castles in Parma and Piacenza (Italy) to establish their real requirements, needs and expectations.

The visitors interviewed are part of a relatively young public (31% between 18 and 25 years old; 23% between 25 and 30 years old); they visit museums and castles two or three times a year in their spare time or during holidays; almost all of them have a mobile phone and 55% of those have a Nokia; relatively few people (15%) have a palmtop device.

The results of the first part of the questionnaire are satisfying: the tourists find the idea of mobile services that are accessible *before* entering the museum very interesting and useful. In particular, they are interested in booking tickets in advance, in receiving information about the museum opening times and any related changes, and in viewing the shortest route to reach the destination.

These services are appreciated by tourists because it will help them find their way around an unknown town and they want to avoid any inconvenience (eg from changes in the timetables), especially during their holidays or a weekend.

In the second part of the questionnaire, dedicated to the specific requirements that arise during the visit inside the museum, the analysis of results highlighted the following issues.

- The services: 'viewing museum plan', 'planning the visit according to personal interest and requirements' and 'reaching the area of interest as quickly as possible' all made a good impression on tourists. It should be noted that several people expressed doubts about the transferability of a museum plan onto a PDA or mobile phone as mobile device screens are small and maps are usually large.
- Opinions are positive about 'viewing a catalogue of works by a particular artist and understanding the artist's techniques'. Few people want or have time to make notes or comments during their visit except for those that visit museums for work or for study purposes.
- Opinions are very positive on the use of an audio guide [32% of the people interviewed gave this a mark of 4 (out of 5) and 32% gave it 5], as it is considered a good alternative to the traditional guide, especially for those who usually visit museums alone.
- Generally, we can say that the tourists interviewed expressed positive opinions on the use of mobile technologies and their applications and interest in the idea.

4 Museum user trial

In parallel with the development of the technical prototypes, the next step was to refine the scenarios. The need was identified for a more concrete instantiation of the scenario to provide detail for the user trials [where the term 'instantiation' indicates that the scenario is to run in a specific place, at a given time, with real users and real outcomes (Evans and Taylor 2005). The instantiation of the test scenarios provided the details of users, content and devices that were required. A decision was made to extend the instantiation to satisfy the needs of the evaluation process. This would include details of the context of use, questions to be answered during the evaluation and the activity or task which would be used to gather responses.

The target users involved in the trial are people – men and women and representing a range of ages – who have an interest in art and would like to have an extraordinary experience visiting a museum, finding useful information on what they see, and increasing their knowledge to answer some questions or satisfy a sense of curiosity raised during their experience.

How will the user trials take place in the museum strand of the MOBIlearn project? Due to limited resources, we require users to speak English or Italian. We can cater for people with severe speech and hearing disabilities or motor impairment, but we cannot include people with severe visual impairment or with manipulative difficulties.

We have divided the target group into three parts:

- students
- tourists
- art experts.

From a pedagogic point of view, for each of the target group established, we have identified:

- motivation
- knowledge
- skills
- learning experience
- personal knowledge improvement
- learning activity requirements.

According to these objectives, the museum user trial should follow this plan.

The test will be introduced with a presentation of the MOBIlearn project and its system (*MOBIlearn System's Introduction*) and interviews with the participant to find out if they are suitable candidates for the test.

Before being selected as test candidates, the possible candidates have to fill in a *Pre-Screening Form* (on a mobile device if possible or on paper) where they insert their information and their *user profile*.

The selected users have to fill in a *Pre-Test Questionnaire* that will be completed at the museum before the usability test.

If the user is:

- a student, the questionnaire is used to test his or her knowledge
- a tourist, the questionnaire is used to understand how much time he or she has for the visit
- an art expert, the questionnaire is used to understand the learning model that is the basis of his/her visit at the museum.

The users will then be divided into 10 groups, each composed of a maximum of five people, and they are asked to:

- do some activities as quickly as possible
- communicate and share contents with others
- find specific information on artists, works of art and the museum.

During the user trial, the user will perform some activities and sub-activities according to the starting point (inside or outside the museum), the type of user (tourist, student or art expert) and his/her user profile.

At the end of the test, the users have to fill in two questionnaires.

- *Post-Task Questionnaire*: completed at the museum after the activities to evaluate the MOBIlearn system and its efficiency.
- *Post-Test Questionnaire*: only for students, filled in at the museum after completing the test, to evaluate their learning with this museum experience.

The results will be analysed to find out which types of problem the users have faced, which activities have been performed best and which content the users have found most interesting.

As stated in the Technical Annex (MOBIlearn 2002), the result of this trial is an extensive evaluation report from external real users that will be the basis for further MOBIlearn exploitation.

5 Conclusion

We have found that the use of scenarios in this way has many features.

- It is multi-stranded, supporting mutually informing dialogue.
- It facilitates the identification of each type and category of requirements.
- It performs a technical role in relation to requirements.
- It provides the missing link between higher-order concepts, such as pedagogy and learning objectives and lower-level implementation aspects.
- It supports verification of system functionality against user requirements.
- It offers a mechanism to support activities linked to user-system interaction.
- It serves to keep the user at the centre of the development process.

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References and further reading

Da Bormida G *et al.* (2002). *MOBIlearn description of work, May 2002*. Available via www.mobilearn.org, accessed 15 September 2005.

Evans D and Taylor J (2005). The role of user scenarios as the central piece of the development jigsaw puzzle. In J Attewell and C Savill-Smith (eds) *Proceedings of MLEARN 2004*. London: Learning and Skills Development Agency.

Gay G, Spinazze A and Stefanone M (2002). *Handscape: exploring potential use scenarios for mobile computing in museums*. At www.cultivate-int.org/issue8/handscape/, accessed 8 September 2005.

MOBIlearn (2002). *Next-generation paradigms and interfaces for technology supported learning in a mobile environment. Exploring the potential of ambient intelligence*. Project No IST–2001–37187. Technical Annex. MOBIlearn Consortium.

MOBIlearn WP2 (2002). Minutes of a MOBIlearn WP2 meeting, 1 July 2002. Unpublished document.

Spinazze A (2002). *Understanding visitor expectations and museums as mobile computing environments: a report on hand-helds in the museum landscape (a CIMI symposium)*. At www.cultivate-int.org/issue8/hssymposium/, accessed 8 September 2005.

Taylor J *et al.* (2002). *MOBIlearn D2.1 Initial requirements, November 2002*. MOBIlearn deliverable to the EC. MOBIlearn Consortium.

How can one effectively assess students working in a collaborative mobile environment on an individual basis?

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Abstract

While wireless technology provides incredible scope for the delivery of curriculum content to common types of ubiquitous wireless mobile device – personal digital assistants (PDAs), mobile phones and laptops – a core problem exists. This concerns the inability to deliver material in the way that the student requires with respect to learning styles, in a context that they understand, and which is appropriate to the learners' various backgrounds or age groups, including those who may have encountered barriers to learning. Such barriers relate to dexterity, computer skills, literacy skills, learning styles, unsuitable delivery methods and bad instructional design of content. This problem is compounded by the lack of a robust assessment model in both instructor-led and computer-directed training. In this paper, a conceptual model called MoDCA (Mobile Device Collaboration and Assessment) is proposed. This model defines how the material/learning objects should be presented and also how the pedagogy should be tailored across the different wireless platforms in such a manner as to promote effective learning and assessment for individuals with diverse learning needs which are continuously changing and adapting.

Keywords
mobile learning environment, collaboration model, evaluation of learning objects, assessment model for learners

1 Wireless devices

The increasing popularity of wireless devices – mobile phones, PDAs, etc (Baldzer *et al.* 2004) – has meant that the scope for the application of wireless communications and services is vast (Falk 2003; Lu *et al.* 2003) – from m-commerce to lifelong learning. The use of wireless devices means 24-hour access, 7 days a week, irrespective of location. This bodes well for lifelong learning as 'wireless communication services may bring about new ways of distance learning and support the concept of learning anytime, anywhere' (Hui, Fong and Lau 2003). In a study carried out at Erskine College in the US, students were asked to answer multiple-choice questions (based on the curriculum content just presented to them), deployed to their palm devices (Falk 2003). Their answers, which indicated how well they understood the lecture content, were 'fed back' to the lecturer within seconds. Being able to identify the material with which the students were having problems meant that the lecturer in question could address these problems instantly. Meanwhile, at the Nanyang Technological University in Singapore, a wireless campus environment was established by developing a personal communications system (known as the personal communicator) that 'integrated various services into a unified platform, providing a one-stop source for both information access and communication … to support the delivery of teaching materials and the exchange of ideas among staff and students' (Hui, Fong and Lau 2003). In a study of this system, a sample of 20 student users assessed the wireless technology as a medium for the delivery of lecture material.

The results from this study indicated an average satisfaction rating of 87%, with regard to the usefulness, availability, relevance and reliability of the delivery medium. However, the authors have noted that in the development of the personal communicator, a single user interface (UI) was used. While this eliminated the need to design multiple interfaces for multiple communication devices, it also negated the importance of and need for user profiling, disregarding the fact that different users learn in different ways, based first on their individual learning preferences (ie visual, auditory or kinaesthetic); and second on their age, profession, experience, gender and cultural background, etc.

Furthermore, while the study in Singapore showed high user satisfaction, the authors also note that neither the end learning experience nor the actual system itself was assessed.

Consequently, the authors contend that while the wireless environment provides great potential for distributed learning (and a resultant enriched learning experience), research to date has shown that the pedagogical aspects of individual user learning (with respect to learning styles and user profiles), user interface issues, collaboration and assessment (from both a system and a learning experience perspective) have not been addressed. Their view is supported by Lu *et al*. (2003) who state that 'while there has been an increasing amount of wireless mobile activity, little attention has been given in the literature to user acceptance of (WIMD) wireless internet via mobile devices'. Wireless applications also need to take into account the changing ways in which people interact with and use information for work and study. Therefore this paper discusses the importance of presentation and assessment within the context of curriculum content delivery across wireless mobile devices. The authors propose a conceptual architecture, MoDCA (a wireless device-based collaborative and assessment model), which takes into account the pedagogical aspects of learning, the psychology of collaboration, the heterogeneous nature of mobile devices (from a user interface perspective) and the importance of effective assessment.

2 Collaboration within a wireless domain

Students learn more effectively through the sharing of ideas with other students and general brainstorming which occurs through the use of collaborative features. Collaboration can be either synchronous or asynchronous, and can include such features as:

1. *talking in groups*: as in a classroom discussion or telephone conference
2. *on a one-to-one basis*: peer-to-peer in the classroom or on the phone
3. *e-mail*: this can exist through the use of standard clients like Outlook or Eudora or can be built into the delivery application
4. *forums*: online question-and-answer sessions/forums with classes (where tutors moderate)
5. *texting*: on SMS-enabled devices
6. *voice-enabled applications*
7. *online folders for files*: these include shared folders on the network or on individual personal computers
8. *videoconferencing*
9. *mentoring*: this occurs when a subject-matter expert engages with the class or individual students in the resolution of issues that the student may have encountered.

The advantages (the appeal of which will vary, depending on the device type, the learning style of the user involved and the capability or bandwidth available) associated with collaboration are multifarious. Some of these advantages include (Nikana 2000):

1. *increased understanding of the material/curriculum content*: through the different collaborative methods and initial delivery approaches, the student is provided with an increased understanding and depth of knowledge regarding the material/curriculum content
2. *increased motivation through discussion*: through group discussion and dialogue, the user is motivated to learn more
3. *quick and effective feedback*: discussion and the repetition of ideas and material (through different presentation formats) reinforces learning, thereby increasing memory retention
4. *cost effectiveness*: by this, we mean that one should not always be 'eager' to develop new interfaces, but instead should use what is available and effective
5. *a good assessment tool for the student*
6. *a good means for the tutor* to identify the level of the student's knowledge
7. *reinforcing*: it acts as a means of reinforcing existing material
8. *alternative views*: it allows for different perspectives to be examined and tested for effectiveness, through discussion
9. *bonding*: increased tutor and student bonding, to help shy and less enabled students to obtain the tutor's attention without embarrassing themselves
10. *student retention*: increased student retention as a result of increased student motivation and understanding.

While the terms collaboration and cooperation are frequently used interchangeably, **Table 1** (Nikana 2000) helps to distinguish differences between these terms.

Table 1 Differences between collaboration and cooperation

Collaborative learning	**Cooperative group work**
The teacher forms the heterogeneous group	Often voluntary group formation
Group members organise joint efforts and negotiate who will perform group maintenance roles	Less formal group activities – at times, individuals are assigned specific roles
Less active monitoring; ie the group resolves issues	The teacher observes and interacts. Small-group social skills training
The group is responsible for each individual's learning; ie group members have to ensure that everyone in the group understands the work	Individuals are responsible for their own learning with group support; ie teaching and learning is a shared experience between teacher and learner
Most commonly used for learning content	Most commonly used for group discussion
Various group and/or individual assessment models	Usually no assessment of formal learning

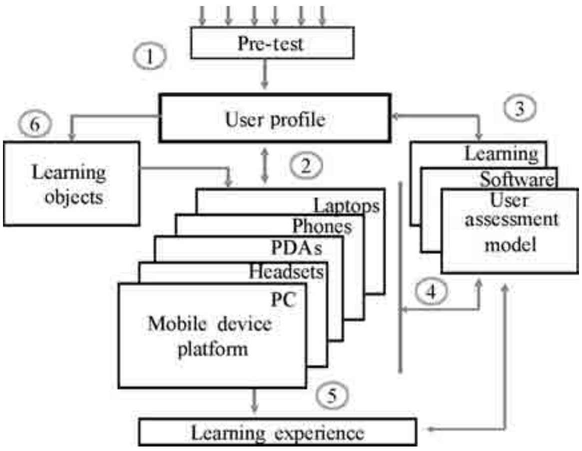
3 The MoDCA architecture

The MoDCA architecture has been designed to address the following question: 'How can one effectively assess students working in a collaborative mobile environment on an individual basis?' The main components of the MoDCA architecture (as outlined in **Figure 1** overleaf) are as follows.

- *Pre-test*: consists of two parts – first, a user questionnaire; and second, some sample curriculum/learning objects presented to the user. This curriculum is used to trace user movements and thinking, based on his/her questionnaire, to confirm, correct or update the information that exists about him/her. All captured information (ie social background, age, experience, gender, layout preference, etc) is input into the user profile and evolves as the system learns about the user. The profile is made up of 15–20 categories of parameter which take into consideration every aspect of the student and his/her learning. Similarly, the system will be aware of changes to either the profile of the user and/or the devices. Based on this information, the system will then present the course material/learning objects in the manner most appropriate to the user and to the device being used, in order to promote effective learning (ie the material will be presented according to the principles of blended learning, in a manner which ensures that both the left and right sides of the brain are kept sufficiently stimulated in order to provide optimum student responses).
- *Mobile devices*: at this point, the specifics of the device are collected and confirmed, the learning objects are displayed based on the characteristics of the specific mobile device and user preferences, and usage is monitored and saved in the user profile.
- *Assessment model*: three models of assessment are used. First, the user's interaction is assessed – that is, are the learning objects presented based on their preferred style of learning? Second, the software is assessed for flaws (which become apparent during learner usage) corresponding mainly to human–computer interaction (HCI) and pedagogical issues. Third, the user's learning is assessed. All information feeds back into the profile and generates a more accurate living profile and living assessment model.
- *Actual assessment*: the profile 'knows' and can detect which device types are being used by the learner. This is critical as the device type being used has a big impact on how the learning objects are both presented and assessed.
- *Learning experience*: based on the user information collected and compared against other users, it will be possible to validate whether or not learning is occurring. If it is found that learning is not occurring, this will feed back into the system and aspects of the way in which the curriculum content is presented and assessed will change dynamically. The system can change the presentation style available, depending on the device and the type and level of assessment. Such presentation styles could include audio output and input, but will definitely allow for collaboration between users, which has been proved to enhance the possibility for learning and the learning experience itself, as it facilitates high-order learning.

- *Learning objects*: a learning object represents the smallest component of a learning item. These objects can be reassembled in different ways and with different presentation styles so as to be suitable for any device. It is also essential, due to problems that currently exist with the delivery of e-learning, that in the delivery of the curriculum content, the available bandwidth be taken into consideration. In that way, the curriculum content is delivered seamlessly and coherently to the user. This is essential in order to maintain the student's attention and confidence in both the delivery mechanism and the curriculum.

Figure 1
The MoDCA Architecture



The MoDCA model will be implemented using software agents to 'push' and 'pull' information from the wireless devices to the distributed servers.

4 Conclusions

Wireless technology provides the potential for the delivery of curriculum content to common types of ubiquitous wireless mobile device. However, the manner in which the material/curriculum content is first delivered and then assessed needs to be addressed. In this paper, a conceptual architecture called MoDCA is presented which takes into account the pedagogical aspects of learning, the psychology of collaboration, the heterogeneous nature of mobile devices (from a user interface perspective) and the importance of effective assessment. In the assessment module, three modes of assessment will be carried out. First, the user's interaction is assessed – that is, are the learning objects presented based on their preferred style of learning? Second, the software is assessed for flaws, corresponding mainly to HCI and pedagogical issues. Third, the user's learning is assessed. All information feeds back into the profile and generates a more accurate living profile and living assessment model. The profile 'knows' and can detect which device types are being used by the user. This is critical as the device type being used has a big impact on how the learning objects are both presented and assessed. The authors believe that the MoDCA model, which applies a user-centred learning and a user-centred assessment approach, addresses many of the problems which exist in current (standard and) mobile learning device applications.

References and further reading

Baldzer J, Suzanne B, Palle K, Jens K, Jochen M, Norbert R and Ansgar S (2004). *Location-aware mobile multimedia applications on the Niccimon platform*.

Falk H (2003). Electronic campus. *The Electronic Library*, 21(1), 63–66.

Hui C, Fong ACM and Lau CT (2002). Unified personal mobile communication services for a wireless campus. *Campus Wide Information Systems*, 19(1), 27–35.

ISO/IEC JTC1 SC36 (2001). *Information technology for learning, education and training. Participation in SC36/WG2 collaboration technologies*. Geneva: International Organization for Standardization/International Engineering Consortium.

Lu J, Chun-Sheng Y, Chang L and Yao JE (2003). Technology acceptance model for wireless internet. *Internet Research: Electronic Networking Applications and Policy*, 13(13), 206–222.

Nikana (2000). Co-operative group work. *Collaborative Learning*, January 2000.

Pailing M (2002). E-learning: is it really the best thing since sliced bread? *Industrial and Commercial Training*, 34(4), 151–155.

A case study on the future options for mobile workplace learning

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Abstract

We describe the application of the Delphi method in studying the future options for mobile workplace learning in one multinational Finnish company. In the first round of applying the Delphi method, the mobile learning experts answered a survey based on six scenarios of mobile learning. The second round took the form of semi-structured interviews, in which the conflicting issues were examined. The aim of the study was to examine the present situation and look at future options for mobile learning which would be feasible and beneficial for the company. More generally, the goal was to explore the connections between mobile workplace learning, personnel development and knowledge management.

Keywords
mobility, workplace learning, futures studies, Delphi method, scenarios

1 Introduction

In this case study, we explore the conditions for the implementation of mobile learning in the operational environment of one multinational Finnish company. In order to discover feasible and beneficial working methods in the future (see eg Bell 1997), we have applied the Delphi method in studying the future options for mobile workplace learning. Mobile learning is understood here as the option to learn independently of place and time, and we approach it from the viewpoint of flexible and lifelong learning. In different situations, learning activities can be supported with different media, and we aim to find out which mobile solutions serve the learner – or worker – best. In considering an individual's learning in the workplace, we focus mainly on non-formal and informal learning activities. On the other hand, learning is seen very much by the company as activities connected to its service processes and personnel development.

2 The Delphi method

The idea behind the Delphi method is to explore possible worlds and their realisations through collecting and iterating expert knowledge. Linstone and Turoff (1975) define Delphi as a method for structuring a group communication process. Basically, the group has at least one opportunity to evaluate and revise its views, and there is always some degree of anonymity attached to the individual responses (Linstone and Turoff 1975; Kuusi 1999).

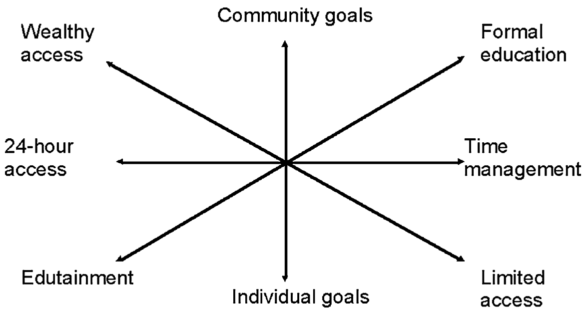
Delphi studies have been criticised for the subjective and narrow views of the experts and an intention to reach an artificial consensus (see eg Linstone and Turoff 1975; Mannermaa 1991; Kuusi 1999). However, Linstone and Turoff (1975) advocate the usefulness of exploring different points of view and Turoff (1975) has introduced Policy Delphi, which pursues several well-founded views of the future. In the case study, we applied the Delphi method as a hermeneutic and heuristic method of collecting and interpreting the expert views, and concentrated mainly on the deviating answers as possible 'weak signals' (ie perceived symptoms of change) in the external and internal operating environment.

2.1 Scenarios of mobile learning as a starting point

Six scenarios depicting different situations of mobile learning were used as stimulating material in the first round of the Delphi method. Instead of the wide scope of futures studies, the scenarios focused on the organisational, psychological and cultural, pedagogical and technological aspects of mobile learning. These aspects represent the contradictory dimensions of mobile learning that may produce so-called 'wild cards' and uncertainties (also 'germs' and 'weak signals'; see eg Kuusi 1999) in the future.

These opposing dimensions (Ahonen *et al.* 2002a) are illustrated in **Figure 1**. This approach is based on earlier studies of future learning practices and mobile learning and teaching technology (eg Gokhale 1995; Bonk and Cunningham 1998; Caldwell and Koch 1999; Bork 2000; Väänänen-Vainio-Mattila and Ruuska 2000; Collis and Moonen 2001; Ahonen *et al.* 2002a, 2002b, 2003).

Figure 1
Possible development trends (and uncertainties) in mobile learning



The scenarios were presented in pictorial and narrative text forms. Six different models of action were depicted using actors, their situations, and their actions with materials at certain times and in certain environments (Mannermaa 1991). Each scenario was followed by an open-ended question about its strengths and weaknesses. The potential strengths, weaknesses, opportunities and threats (SWOT) in relation to mobile learning were also summed up in statements after each scenario.

2.2 The second round of Delphi: expert interviews

The disagreements arising from the first-round responses were further explored in semi-structured interviews with the aim of bringing out the underlying reasons for the differing points of view. The goal was to produce some plausible future views of mobile learning which would conform to the company's needs and its scope for action in different contexts – in different units and countries. The interviews in Finland were conducted face-to-face; while in other countries (France, the UK, the US), teleconferencing was used, supported by a web-based working environment.

3 Findings

In our case-study organisation, there are differences between countries, cultures and units as regards technology acceptance and adopting new ways of working and learning. Also, views about workplace learning and about the necessity of evaluating its outcomes differ. We cannot see one future scenario for converging mobile workplace learning, personnel development and knowledge management in the multicultural environment. Instead, there seem to be many different options for the future.

According to both the survey and the interviews, the main reason for applying mobile working and learning practices in our case-study company was efficiency. Working in virtual teams cuts travelling expenses and enhances time management. Accompanying working methods are perceived to be effective and this facilitates their spread across the company. At their best, mobile solutions connected to the operational systems help to streamline the business processes; for example, they enable communication of real-time information from the field of operations.

As a starting point, the assured status of the unit within the company and its level of integration into the organisational culture are the preconditions for adopting different types of mobile operation. Culturally, digital presence adds a new global sense of community and belonging to the same organisational culture. The basic condition is still the level of IT infrastructure needed for mobile operations. Vital steps in launching new services are the maturing of the technologies, the usability of the systems and the competitive advantage gained with the different forms of mobile work and learning. Instead of approaching the human resources (HR) development in the spirit of lifelong learning, more weight is still put on recognising key skills from the viewpoint of organisational activities and developing competences. Mobility is applied to the actual needs of the company in terms of flexible learning and working.

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References

Ahonen M, Joyce B, Kotala O, Peltola K and Turunen H (2002a). *Scenario work in* [the] *Digital Learning project*. Working paper (unpublished).

Ahonen M, Koponen H, Syvänen A and Turunen H (2002b). Uudet mobiili-innovaatiot oppimisen tukena. In *Digital Learning-tutkimusprojektin osaraportti. Hämeenlinnan ammattikorkeakoulun julkaisusarja A: 4/2002*.

Ahonen M, Joyce B, Leino M and Turunen H (2003). Mobile learning – a different viewpoint. In H Kynäslahti and P Seppälä (eds) *Mobile learning*. Helsinki: IT–Press, 29–39.

Bell W (1997). *Foundations of futures studies: human science for a new era. Vol. 1. History, purposes, and knowledge*. New Brunswick (NJ): Transaction Publishers.

Bonk CJ and Cunningham DJ (1998). Searching for learner-centered, constructivist and sociocultural components of collaborative educational learning tools. In CJ Bonk and KS King (eds) *Electronic collaborators: learner-centered technologies for literacy, apprenticeship, and discourse*. Mahwah, NJ: Erlbaum, 25–50.

Bork A (2000). *Four fictional views of the future of learning*. Internet and Higher Education, 3, 271–284. At www.ics.uci.edu/~bork/fiction.pdf, accessed 25 November 2003.

Caldwell D and Koch J (1999). *Mobile computing and its impact on the changing nature of work and organizations. Working paper 24*. Santa Clara University. At http://sts.scu.edu/research/MobileComputing.pdf, accessed 25 November 2003.

Collis B and Moonen J (2001). *Flexible learning in a digital world: experiences and expectations*. London: Kogan Page.

Gokhale AA (1995). Collaborative learning enhances critical thinking. *Journal of Technology Education*, 7(1).

Kuusi O (1999). *Expertise in the future use of generic technologies. Epistemic and methodological considerations concerning Delphi studies. Research Report No 59*. Helsinki: Government Institute for Economic Research.

Linstone HA and Turoff M (1975). Introduction. In HA Linstone and M Turoff (eds) *The Delphi method. Techniques and applications*. Reading: Addison–Wesley, 3–12.

Mannermaa M (1991). *Evolutionaarinen tulevaisuudentutkimus. Tulevaisuudentutkimuksen paradigmojen ja niiden metodologisten ominaisuuksien tarkastelua. Acta Futura Fennica 2*. Helsinki: Tulevaisuuden tutkimuksen seura.

Turoff M (1975). The Policy Delphi. In HA Linstone and M Turoff (eds) *The Delphi method. Techniques and applications*. Reading: Addison–Wesley, 84–101.

Väänänen-Vainio-Mattila K and Ruuska S (2000). Designing mobile phones and communicators for consumers' needs at Nokia. In E Bergman (ed.) *Information appliances and beyond*. San Francisco: Academic Press.

van der Heijden K (1997). *Scenarios, strategies and the strategy process*. Breukelen: Nijenrode University Press. At http://library.nyenrode.nl/NL/publicaties/NIJREP/nijenrode.html, accessed 17 November 2003.

Approaches to just-in-time learning with mobile phones: a case study of support for tourists' language needs

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Abstract

The INLET project (Lingua 1)[1] demonstrates techniques for promoting the contextualised learning of introductory Greek language at the Olympic Games in 2004. This paper will review the implications for understanding motivation in language learning, as well as more general underlying principles for approaches to providing ubiquitous just-in-time knowledge that involve Short Messaging System (SMS), including an SMS-searchable database.

Keywords
Greek language, Olympic Games, language support, motivation, ubiquitous, just-in-time, SMS

1 Project overview

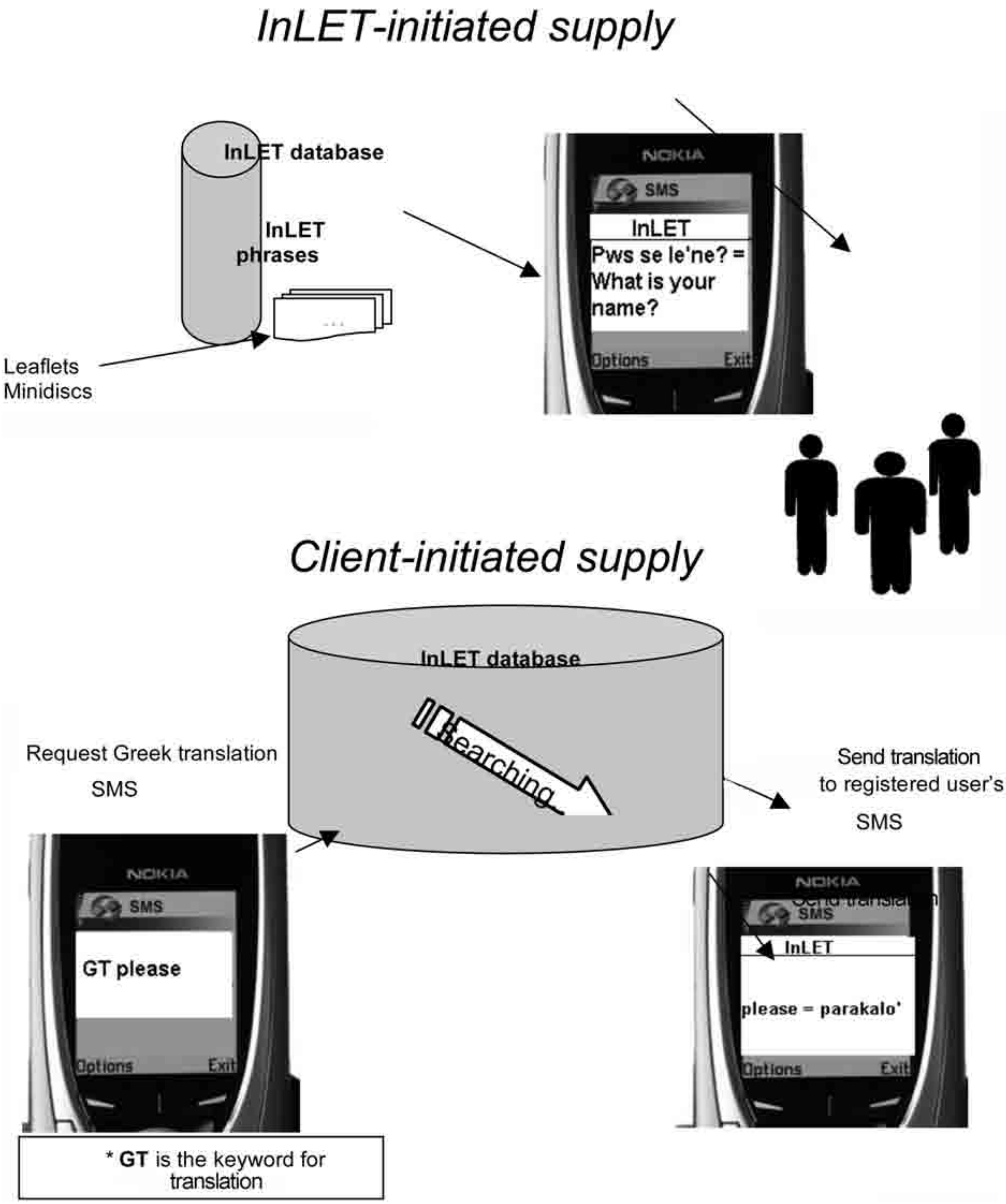
The project entitled InNLET (Introducing Language Enhancement Techniques) was tendered under the European Union's (EU) Socrates Programme as Lingua 1 to Eleni Malliou, Savvas Stavros and Sofoklis Sotiriou of the Ellinogermaniki Agogi in Chalandri, Greece; and to Antonis Miliarakis and Manolis Stratakis of *FORTHnet* SA, in Heraklion, Crete.

Technically, it is relatively straightforward. Tourists coming to Greece for the Olympic Games will receive:

- booklets at airports, hotels and sports venues explaining the language help available
- some useful Greek phrases in the booklets
- a minidisc with the same information as in the booklets
- a phone number to register their interest
- SMS messages sent regularly to their mobile phone with useful phrases
- the facility to request and receive SMS translations from or into Greek.

Figure 1 (overleaf) shows the InLET system, with InLET-initiated and client-initiated supply.

Figure 1 InLET system, with InLET-initiated and client-initiated supply



2 Educational aspects of INLET

2.1 Features of ubiquitous support

The parameters of the project fit with generally agreed principles for ubiquitous support as shown in **Table 1**.

Table 1
Principles of ubiquitous support

Advantages	Limitations
Portable	Physical limitations
Personal	Psychological limitations
Access	
Multi-device delivery	
Multi-user	
Multi-language	
User management	

Table 2 lists some sample application categories (see Clark 2003).

Table 2
Some sample application categories

Sample applications
Diagnosis
Self-assessment
Performance support
Language learning
Collaboration
Online mentoring
Reinforcement

InLET adds another application to the list, namely *information supply*. We can consider the output of the project under two headings.

- *Information supply*, where we will find it links with performance support
- *Language learning*, though we would revise this to language supply. There are different factors to consider under each heading.

2.2 InLET information supply

InLET recognises the common fact that people on the move need information in three ways – in different spaces, in different areas of life, and at many different times (McLean 2003). But this does not necessarily follow an m-learning paradigm where the ultimate assumption is a transformation of learning styles (Vavoula and Sharples 2002). In that paradigm, the principal pedagogical considerations to be taken into account would be (Singh 2003):

1 urgency of learning need
2 initiative of knowledge acquisition
3 mobility of learning setting
4 interactivity of learning process
5 situatedness of instructional activities
6 integration of instructional content.

But we revise this list to fit information supply, without assumptions of learning on the part of the user:

1 urgency of *information* need
2 initiative in *information* acquisition
3 mobility of *setting*
4 interactivity of *process*
5 situatedness of *needs*
6 integration of *content*.

Chen *et al.* (2002) noted four trends in mobile applications.

- The first is a move from courseware to ‘performanceware’ – that is, the stand-alone learning content model needs to be transformed into a context-driven, task-sensitive, performance-support model. In our model, there is performance, but not necessarily learning.
- The second is a move from instructional design to performance-based design, where compiling content and courses is transformed into job, task, activity and business application context analysis. Our model is based on activity and application context analysis.
- The third is a move from course management to business workflow, where business workflow and processes become the delivery platform for mobile learning and performance support. Our model exemplifies a move towards activity flow and performance support.
- The fourth is from mouse-and-click to pen-and-voice interface, which our model clearly follows.

These trends are exemplified in relation to language provision in the next section.

2.3 INLET language provision

Given the well-known current obstacles of limited memory storage, small screens and intermittent connectivity (Vavoula and Sharples 2002), we agree with the recommendations of McLean (2003) – that any initiative must either improve on existing practices or do something that cannot be done using existing technologies and practices, and that there should be no attempt to provide a total solution to any learning programme. Thus, in considering the language issue for tourists at the Athens Olympic Games in 2004, it was clear that learning even elementary Greek would not take place in a period of 1–3 weeks. Clearly, it was linguistic performance activity of some kind that tourists would require. We therefore considered which were likely to be the most useful linguistic activities that a tourist would normally wish to perform; and then, which would be most useful to our specific subset of tourists.

An inspection of a typical pocket Berlitz dictionary and phrase book for travellers shows 2500 dictionary items, seven pages of basic grammar and pronunciation, and 140 pages of phrases in the categories: arrival, hotel, eating out, travelling around, sightseeing, relaxing, making friends, shopping, money, post office and doctor. This is clearly more than information supply; it is an aid to learning as well as just-in-time performance support.

To follow our goals meant that we needed to select a small subset of the categories. There was no ready research information to guide that selection. We therefore used our judgement that the following categories of words and phrases would fulfil the most urgent Greek language needs for a tourist spending only a few days in the country.

- *Basics*: greetings and other polite phrases, naming, numbers, and words like ‘come’, ‘need’, ‘know’, ‘help’, ‘wait’, ‘have’, ‘like’, ‘want’, ‘is’, ‘am’, ‘are’, ‘very’, ‘passport’.
- *Where*: ‘Where is?’, ‘here’, ‘there’, ‘right’, ‘left’, ‘in’, ‘to’, etc; ‘by taxi’, ‘bus’, ‘subway/underground/metro’, ‘train’, ‘on foot’, ‘street’, etc.
- *When*: ‘now’, ‘later’, ‘today’, ‘tomorrow’, ‘What is the time?’, days of the week, etc
- *Olympic sports*: ‘Olympic Games’, ‘archery’, ‘athletics’, ‘fencing’, etc
- *Buying*: ‘money’, ‘credit card’, ‘How much?’, ‘expensive’, ‘cheap’, ‘sales’, ‘buy’, ‘I would like’, etc.

Languages used in the InLET system are Greek, English, German and Slovenian, based on the perception that English is the world’s *lingua franca*, and the other two were languages of a prior existing partnership, but also covered a range of people likely to attend the Olympic Games.

We feel that our language choices supply information in terms of the categories listed in section 2.2. Clearly, all the *needs* we cover would be strongly ‘situated’, with an urgent need for the Greek language *information* in the specific situation, which would vary according to the mobility of *setting*. Our system is designed in such a way that some of the dictionary items are supplied to the mobile users by SMS on a regular basis several times every day. Others are available by request, so that users take the initiative in acquiring the *information* through the mobile interactivity *process*, in which the users themselves integrate the situation and the *content*.

In other words, we fulfil the main goals of just-in-time learning, even though we do not assume that users will necessarily retain the information as language knowledge. Nonetheless, we are offering information that is available at any time and in any place, and also information on demand. Finally, the users themselves determine whether and how they will engage in developing short-term skills learning when they attempt to understand or say the Greek words and phrases.

2.4 Why language provision by SMS?

The system as described actually provides what a book does. So the question arises: why develop our system rather than assume tourists could buy their own phrase books?

First, we could not assume they would come with helpful books, so booklets with some useful Greek phrases to be picked up at airports, hotels, and sports venues would fulfil a need. Second, for those with minidisc players, we offer the sounds of the language as well as the written form. Third, the SMS messages sent regularly to their mobile phones with useful phrases would be a constant reminder of the real possibility of communicating – even minimally – with members of the local community. Fourth, we incorporated items that are more targeted than a standard tourist phrase book would be. Fifth, even though learning Greek is not an aim we expect in a tourist to the Olympic Games, all our messages could be saved by the users and therefore reused as often as needed, and perhaps ultimately learned.

However, perhaps the strongest motivation for the project was not to fulfil the needs of the traveller to the Olympic Games, but the needs of Greece as a minority-language state within the EU. We recognise the current limited interest in other languages, and that we are dealing with people with a very *low motivation* to learn that language. Why, then, should they use any Greek at all? Our answer is that we want them to 'feel' a connection to Greece and its people. For Greeks, this has to be linked to the language, even though there are many people who are deeply interested in Greek history and culture, especially that of Ancient Greece, with no knowledge of, or interest in, the language. But we feel that by enabling visitors to say and understand at least some very minimal, basic words, a rapport with Greek people might be established in ways that would not happen just by using English. This is what we often call phatic communication; it does not really convey anything informative (ie facts), but it establishes an emotional bond.

We need to motivate them to make the effort to try to use Greek; and, as we all know, a small effort is usually more likely to be undertaken than a bigger one, especially if it attracts attention by being in some way *unusual or unexpected*. People are less likely to reject an offer if it is *easy to cope with* and it *does not cost them anything*. The InLET project design meets these requirements.

It has never been done before in quite this way. People with mobile phones may have learned to receive unsolicited advertising SMS messages, or messages from their connection provider, but not free material that would be of genuine use to them (although, admittedly, some advertisements are useful). The InLET system is therefore likely to arouse some curiosity. It is easy to cope with, even while the user is doing other things – for example, travelling with distractions in the background and therefore with a lower level of concentration. The SMS messages will be short – no more than 160 characters. Use of the minidisc is also quite simple for anyone who has a MiniDisc Walkman. Finally, registering the phone number and opening incoming SMS messages is not difficult and will be free.

The author did a small but international survey of more than 200 mature adults studying in the Online Education and Training course at the University of London,[2] to discover whether people would want the help we are offering. The results are surprising, perhaps, and disappointing. By definition, being on this course, these students were all ICT-literate people, and had chosen to improve their skills even more. Yet half of them said they did not want to receive the SMS help. One respondent was very violently opposed, claiming he could learn the language better in a person-to-person way in the tavernas, playing cards and drinking ouzo with the village Greeks. He misunderstood InLET's goals, which were not to teach the language. However, such responses to a hypothetical question posed out of context need not, perhaps, be taken too seriously, since the same people could respond quite differently if asked while actually in Greece. This remains to be verified during the Olympic Games.

Overall, the project highlights contemporary uses of ubiquitous technology that are highly likely to have an impact upon more learning and teaching methods as palm devices are integrated with internet-connected mobile phones and supplied with fold-away keyboards. It clearly has wider educational implications for any learning that involves no teacher and is oriented towards short-term skills without the implication of longer-term learning.

References

Chen YS, Kao TC, Sheu JP and Chang CY (2002) A mobile scaffolding-aid-based bird-watching learning system. In M Milrad, HU Hoppe and Kinshuk (eds) *Proceedings of the IEEE International Workshop on Wireless and Mobile Technologies in Education*. Los Alimatos, CA: IEEE Computer Society, 152–156.

Clark D (2003). *M-learning. The best place to learn? No place*. At www.epic.co.uk/content/resources/white_papers/m-learning.htm, accessed 12 September 2005.

McLean N (2003). *The m-learning paradigm: an overview*. At www.oucs.ox.ac.uk/ltg/reports/mlearning.rtf, accessed 13 September 2005.

Singh H (2003). *Leveraging mobile and wireless internet*. At www.learningcircuits.org/2003/sep2003/singh.htm, accessed 13 September 2005.

Vavoula GN and Sharples M (2002). KleOS: a personal, mobile, knowledge and learning organisation system. In M Milrad, HU Hoppe and Kinshuk (eds) *Proceedings of the IEEE International Workshop on Wireless and Mobile Technologies in Education*. Los Alimatos, CA: IEEE Computer Society, 152.

Endnotes

1 The InLET project (EU project reference no 109926–CP–1–2003–1–GR–LINGUA–L1) was originated by Eleni Malliou, Savvas Stavros and Sofoklis Sotiriou (Ellinogermaniki Agogi, Chalandri, Greece) and Antonis Miliarakis and Manolis Stratakis (FORTHnet SA, Heraklion, Crete). Partners in the project are:

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- Eleftherios Venizelos International Airport of Athens, Greece
- Milos Educational Women's Collaboration for Activities in Tourism, Greece
- Community Service Volunteer Media, UK
- Radiotelevizija Slovenia
- Nederlandse Christelijke Radio Vereniging.

2 For information on the Online Education and Training course for professionals involved in education, see www.ioe.ac.uk/english/OET.htm, accessed 10 September 2005.

Mobile lessons: concept and applications for 'on-site' geo-referenced lessons

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Abstract

We have coined the term 'mobile lesson' to express the concept of lessons carried out directly on site. Mobile is the keyword to be emphasised because all actors (teachers, tutors, students) in a mobile lesson are free to move within sites of educational relevance, and by means of mobile devices – Tablet PC, personal digital assistant (PDA), smartphone equipped with a Global Positioning System (GPS) – and geo-referenced applications, are able to perform educational activities on the spot. Suitable disciplines for mobile lessons include history, geography, physics, biology and linguistics and ideal scenarios are archaeological sites and natural parks. Each point of interest for the lesson is expressed in latitude–longitude coordinates and is called a 'hotspot'.

The technical infrastructure for mobile lessons consists of a web browser augmented with GPS capabilities and a web service able to generate dynamic content according to the actual position of the end user.

We have chosen a web-based architecture because web browsers are commonly available for a large number of platforms such as PCs, PDAs and smartphones.

The browser has been extended with a customised add-on which is able to read the current position from GPS hardware and adds a 'user-location' header to each http request. The web applications can return web pages created on the fly and tailored for the end-user position.

Keywords
mobile lesson, GPS, web

1 Introduction

We coined the term 'mobile lessons' for lessons held outside the classroom. During a mobile lesson, all actors (teachers, tutors, students) are mobile and have to move to perform the required tasks.

Topics and disciplines that may benefit from the mobile lessons format are geophysics and mineralogy in geography, the study of monuments in history or trees and ecosystems in biology, distance measuring in physics and geometry, and dialects in linguistics.

Mobile lessons are not a new teaching technology or methodology (Du Boulay and Luckin 2001), but they are a way of making lessons more efficient and more attractive using new communication technologies and mobile devices. Students can improve their knowledge directly on site, looking for information, observing the real environment, and feeling more involved because they are able to behave autonomously (Rogovin 1998). To integrate mobile devices into our 'on-site' approach, we designed and implemented software that helps teachers to create and edit lessons that will later be delivered to students and accessed through mobile devices. Finally, the mobile lesson format allows teachers to monitor students' activities while they are on site (Giroux *et al*. 2002).

2 Organisation of a mobile lesson

A mobile lesson comprises four main steps.

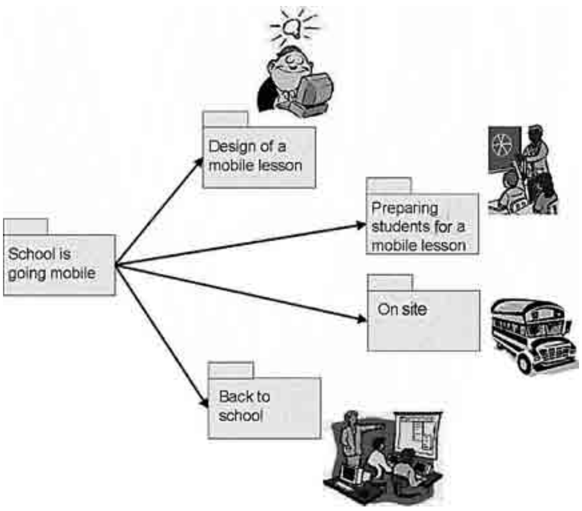
The first step concerns the *lesson design*: teachers and/or tutors choose the scenario (eg an archaeological site or a natural park), go to the site, choose particular points of interest (called hotspots), and mark them with their GPS coordinates. Then, either in the hotspot or later in the school, they prepare the pedagogical material such as historical information, hotspot descriptions, observation instructions, help and tips. They can also prepare quizzes and tests, both relating to the whole scenario and to particular hotspots. This entire step is performed by means of the mobile lessons authoring tool.

The second step is a *'traditional' lesson in the classroom* to impart to the students the background knowledge required to appreciate fully the content of the on-site experience. The lesson should also explain the technical equipment they are going to use.

The third step is the *on-site experience*. Students and teachers are free to move around the scenario with their mobile devices. Students have to discover the hotspots previously chosen by teachers and the software provides them with every geo-referenced piece of information prepared by the teachers in the first step. The mobile lessons can be like a treasure hunt, where students receive a score for every hotspot found and for every quiz question answered.

The fourth and last step is performed *back in the classroom*. Teachers conclude the lesson by assessing the results of the experience and focusing their attention on pedagogical corrective actions for those students who have achieved poor results. **Figure 1** shows the four main steps of the mobile lessons concept.

Figure 1
The four main steps of the mobile lessons concept



3 Design goals

The three main design goals for the mobile lessons system are as follows.

- Devices must be online and communicate with a central server containing all relevant data. We disapprove of the use of offline devices with preloaded data because keeping every device up to date is a tedious task.
- We do not want to write from scratch a brand new multimedia interactive application for the device. We want to reuse as much material as possible from existing software.
- We do not want to define and implement a new client-server protocol, but instead we prefer to use a reliable implementation of the HTTP protocol which is well tolerated by firewall/router security policies.

The design goals stated above lead to an architecture based on a web browser, augmented with a GPS interface and a web service able to generate dynamic content according to the actual position of the end user.

The 'augmented browser' is part of the GPSWeb Project (Carboni *et al.* 2004). We have chosen a web browser for three reasons.

- It is commonly used by a large number of users.
- It is included in a wide set of devices, such as PCs, PDAs and smartphones. Although each browser provides its own user interface (UI) (sometimes customised with original solutions, such as tab panes or third-party toolbars), common basic functionalities are easily found and accessed by users.
- It allows developing applications using common scripting languages (PHP, ASP and so on) and the existing ones can be adapted with few changes.

The GPSWeb module is available for Mozilla Firefox and Microsoft Internet Explorer. The module reads the user's current position from the available GPS hardware and adds the 'user-location' HTTP header to each browser request. The web applications return web pages created on-the-fly which are specific for the position given in the header.

The clients are notebooks and Tablet PCs with GPSWeb-enabled browsers that are connected through serial or Bluetooth ports to GPS devices and able to access the internet via General Packet Radio Service (GPRS) connections – although it can be used on small areas with wireless local area network (WLAN) coverage, the application does not rely on a specific network infrastructure.

The web application is developed in Java and PHP and a MySQL database – a popular open-source database – is used to store any information that is relevant to a mobile lesson.

4 The experiment

The archaeological site of Nora, in southern Sardinia, has been selected as the scenario for our first mobile lessons experience. The site has 13 hotspots, such as the Temple of Aesculapius, the main Roman street, the theatre, the thermal baths and so forth.

For each hotspot, the teachers specified the name, a brief description, quizzes, pedagogical material and the radius of the area of interest (AOI) with the hotspot at its centre. When the students were on the site with their GPSWeb-enabled clients, they asked to start the quiz. If their position was inside the AOI for that hotspot, the quiz was presented to the students. Otherwise, no quiz was shown and the student lost marks. All questions and answers were stored in the mobile lessons database.

The experiment has revealed several positive aspects of the concept and applications of mobile lessons. The teachers and students involved were very excited about the on-site experience, confirming the effective pedagogical validity of the innovative approach of our project. Students find it more interesting to have a direct contact with what they are studying and the competition among classmates is an exciting incentive. The teachers find software tools useful in helping them to create lessons, to prepare quizzes, and to analyse student answers.

5 Conclusions

We have presented the mobile lessons experience, based on web technologies such as the GPSWeb tools. Connected mobile devices provide valid support for instant information access and the GPS-enabled browser improves data processing on the server side. At the same time, on-site lessons are a very exciting experience for both teachers and students. By means of a standard web browser, teachers can define and modify the lesson whenever they want (even during the on-site lesson, if needed), while only information or quizzes related to a specific area are presented to students. Tests carried out at the archaeological site of Nora in Sardinia have shown the practicability of this new mobile learning experience. Since wireless technologies are rapidly evolving, mobile lessons will have several benefits and we can imagine replicating the same experience in the future with Universal Mobile Telecommunications System (UMTS) phones or wireless networked (Wi-Fi) PDAs.

References

Carboni D, Giroux S, Piras A and Sanna S (2004). The web around the corner: augmenting the browser with GPS. In *Proceedings of the WWW2004 Conference, Alternate Track Papers and Posters*. New York: ACM Press, 318–319.

Du Boulay B and Luckin R (2001). Modelling human teaching tactics and strategies for tutoring systems. *International Journal of AI in Education (IJAIED)*, 12, 235–256.

Giroux S, Moulin C, Sanna R and Pintus A (2002). Mobile lessons: lessons based on geo-referenced information. In *Proceedings of the World Conference on E-Learning in Corporate, Government, Healthcare and Higher Education*. Charlottesville: Association for the Advancement of Computing in Education (AACE), 331–338.

Rogovin A (1998). *Learning by doing: home and school activities for all children*. Nashville: Abingdon Press.

m-learning via the web: the challenge of size

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Abstract

'Dealing with size' is one of the critical challenges in developing mobile learning elements.

How can we fit all we need onto such a small screen?

How can we support a wide range of mobile technologies, yet not get lost in the 'lowest common denominator'?

During the past 3 years, the m-learning development teams have found various ways of addressing these issues, both technologically and pedagogically. This paper will focus on two zones of this development, and solutions we have found will be presented and discussed.

Keywords
XHTML, mobile learning, screen design, interface

1 The m-learning project

The m-learning project is a 3-year pan-European collaborative research and development (R&D) programme supported by the European Union (EU). The project has developed prototype products and innovative approaches designed to support learning, particularly literacy, numeracy and life and survival skills, using handheld devices such as mobile phones and palmtop or pocket computers. A key objective is to engage with and motivate young adults who are not engaged in education or training, particularly those who are unemployed or homeless.

The consortium is a partnership of organisations – the Learning and Skills Development Agency (LSDA), Cambridge Training and Development (CTAD) and Ultralab from the UK, Lecando from Sweden and Centro di Ricerca in Matematica Pura ed Applicata (CRMPA) from Italy – combining skills in pedagogy and technology. The project has funded 100 devices (SonyEricsson P800s and P900s; O_2 XDA2s) which are currently being used by 300 learners in the three partner countries.

To deliver a rich learning experience, we are using a range of technologies including: Multmedia Messaging System (MMS), Short Messaging System (SMS), Extensible HyperText Markup Language (XHTML) (PHP, ASP, JSP, java servlets), Wireless Application Protocol (WAP), Java 2 Platform, Mobile Edition (J2ME), JavaScript and Flash.

This paper will focus on the development and design factors that were raised in the use of mini-browser technologies. Although size might appear to be an overriding factor, there were other considerations that were equally, if not more, important. This paper addresses some general points and discusses some possible solutions.

2 Development and design factors

Systems and content were developed primarily for mini-browser technologies. This major technological choice was influenced by research carried out at the beginning of the project by the project partners and by external indications of developing trends within the mobile technology market. A number of factors were considered and these influenced the design.

The overarching factor, of course, was the focus of the project as described above, which influenced all designs and choices. Beyond this, the profile of the target group, both in terms of age and potential problems with literacy, strongly influenced both the way that the materials and systems were presented and the content of the materials. An important point that needed to be considered was the fact that the m-learning project lasted for 3 years, during which time there were many developments in the features and services which mobile phone manufacturers and providers offered. This forced us to adopt a flexible approach which would be able to assimilate these new technologies as they appeared.

The main foundation of this was the adoption of standards which were firmly embedded in the technology world and which extended outside the mobile world: hence, we chose web delivery as the primary means of delivering content and systems, especially via the emerging XHTML standard with its profiles for different platforms.

The limitations of using mobile devices for web delivery introduced barriers which strongly influenced designs, content and methods of delivery. Arguably, the major barrier was screen size. Having said that, the devices also introduced possibilities in terms of their implicit communication and multimedia features.

3 Zones of development

Development in the m-Learning project can be divided into several areas including content, navigation structures, a portal, a page-creation tool for user-generated content, a mediaboard, a learning management system (LMS) and a profile-based course management agent. This section presents some of the issues that arise when designing web-based material and services for devices with small screens.

3.1 Learning objects

The learning objects are focused learning materials, including test items and materials for practising specific skills. There is a strong emphasis on visual richness, colours, animation and sound effects, based on feedback from earlier trials. These are some of the lessons we learned.

- *Learning goals*: both Virtual Learning Environment (VLE) and stand-alone delivery had to be considered. Short, sharp pieces of learning that focused on specific sets of skills and levels were well received by learners. A 'quick reference' or 'focused skill update' type was more effective than a 'complete package' approach.
- *Device-specific development*: despite the use of device-independent standards (eg XHTML) we were unable to create a rich learning experience that could span all our devices. Instead we customised our materials for specific device 'families'. Thus richer media was available to our learners who were using a Pocket PC (O_2 XDA2) than those using the Symbian operating standard (SonyEricsson P900).
- *Scripts to span technologies*: writing effective materials is costly. Although the finished materials did not span devices, the master scripts did. We focused on specific learning themes and skills, then wrote the scripts so that they could be developed into a slightly different learning experience for each technology 'family'. For example, a text-message quiz (SMS), a mini-web quiz (XHTML) or a rich media mini-web quiz (Flash) could all convey the same learning message.
- *Different solutions for different gadgets*: our learners demanded high graphic values, fast download, rich interactivity. These seem impossible with a tiny screen, a minimalist browser and low bandwidth. The solutions we found were different for each handset, but involved combinations of pre-cacheing, Stylesheets, client-side scripting, XHTML compression and Flash Apps loading external XML (for the XDA).
- *Browser quirks*: mobile web browsers bear a strong resemblance to the early days of computer-based web use, when nothing was standard and every browser was full of quirks. XHTML standards are well established, but there is a wide range of differences in the way that the different handsets can render the pages. Some manage full Dynamic HTML (DHTML) and client-side scripting. Others look more like a WAP page. It was necessary to test everything as widely as possible, especially when including client-side functionality with the page.

3.2 Page-Builder: a case study

Given the length of this paper, we cannot address all aspects of the project, so we have chosen to present a case study of the page-building software to illustrate some of the issues. The m-learning Page-Builder system addressed one of the VLE aspects of the delivery. It was designed to allow 'through the web' creation of web pages in a password-protected environment. It supplies tools which allow the users to make pages based upon templates which themselves are created in the same environment. It has a number of predefined elements which can be put on pages to encourage collaboration within the environment including lists of links, web logs (blogs) and one-thread debates. These elements can sit alongside text, images, animations and other 'static' page elements.

The system makes use of 'browser steering' to format automatically the pages for a particular device. It does have a generic set of configurations which try to accommodate most browsers, the principle being the use of percentage widths on all elements, so users on screens which are tall and thin still only have to scroll up and down and not side to side. Sets of configurations can be quite easily created for specific browsers/devices and the user agent string of a particular browser can be associated with that set. If an unknown user agent string is encountered, then the generic is used and a message is sent to whomsoever administers the system.

In many ways, this differs quite radically from the principles adopted for the development of the stand-alone learning materials as described in section 3.1. The Page-Builder was created to try to accommodate any browser and system, building pages 'on the fly' for that browser. In some ways, the challenge of screen size was passed on to the users of the system when they create their own content. However, this is not totally true. Considerable thought was put into designing the tools which allowed the users to create the pages and the elements which inhabited them. Special effort was given to designing small but meaningful icons for actions such as editing, creating, deleting, linking, moving and sending elements/pages. These also needed to be used throughout the system in a consistent way. The types of operation and the types of object had two distinct sets of icons that could be amalgamated. So there was an icon for a page, a picture, a debate, etc; and an icon for edit, create, delete, etc. These could then be combined to form edit–page, delete–page, edit–text and so on. In effect, we were creating a small iconic language for users to manipulate the system, which would be, it was hoped, meaningful and also not language-specific.

The main problems we encountered, however, were with screen size. It transpired that the icons had to be made so small that meanings were hard to convey, especially as it proved very difficult to combine them at this size. The final size which allowed the best fit on most handheld systems was 12 x 12 pixels. At this size, the amalgamations were so small that they could barely be identified. As a result, it was decided that they should be used alone, allowing the context to convey the meaning in terms of what the icon was operating upon. So if the 'delete' icon was found next to some text, you could assume that you were deleting that text. This proved to be less than successful as the users found it quite hard to understand what the icons meant when they were isolated in this way. Also it proved quite difficult to create effective icons that convey conceptual tasks which do not, as yet, have standard accepted imagery – for example, 'create', 'new' and 'edit'.

In the version which is currently being used by our research population there is a mix of words and icons, depending on where they appear on the page. It is hoped that we will be able to get feedback as to the comparative effectiveness of these two approaches from the learners at the end of the project.

4 Lessons learned

This is an ongoing project, and we are continuing to address the points that have been raised in this paper. The issues that are listed in section 3.1 are the central focus of our research at this stage, and we are undertaking further investigations and development work in response to these considerations. Interaction with the learners themselves necessarily forms a major part of this investigative work. The creation of complex, media-rich systems on small screens is a challenge for all projects that incorporate mobile devices, as is the breadth and disparity of devices currently available. Our research is likely to have implications for the market both within and beyond educational and learning technologies.

References

ATG (2002). *Microportals: the big need for little portals*. White Paper. At http://whitepapers.zdnet.co.uk/0,39025945,60041872p-39000536q,00.htm, accessed 14 September 2005.

Childs B (2003). *Web development guidelines* [Smartphone 2002]. Orange Multimedia Operations.

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

Lindgren M, Jedbratt J and Svenson E (2002). *Beyond mobile*. Palgrave.

Melton RF (2002). *Planning and developing open and distance learning*. RoutledgeFalmer.

Traffic (2004). *Website*. At www.traffick.com/, accessed January 2004.

W3C (2004). World Wide Web Consortium website. At www.w3.org/, accessed January 2004.

WAPF (2001). *XHTML mobile profile*. La Jolla, CA: Wireless Application Protocol Forum Ltd [now part of Open Mobility Alliance (OMA)].

E-learning to m-learning: an investigation into the potential for content conversion

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Abstract

This research paper explores the potential for using learning objects to implement content for mobile learning, and the viability of reuse of existing e-learning materials in a mobile environment.

By drawing on the results of this evaluation and using tools provided by MOBIlearn (2005) – a pan-European research programme exploring the use of mobile learning – a viable model for development and reuse of learning objects is described and a process is proposed for converting existing e-learning content for mobile devices.

Developing new course content specifically for m-learning is an expensive and time-consuming process which will require at least a reasonable knowledge of the learning content, learning and teaching issues and software engineering. There is a multitude of e-learning content in the current marketplace and vast sums of money have been spent on such content development; therefore it makes sense to look at the possibilities of converting existing content into a format that could potentially operate on mobile devices, rather than reinventing the wheel.

Much e-learning content is well established and has been developed by educators and technologists exploiting current research outcomes in learning and software development. In order to benefit from this knowledge and expertise, a research project was undertaken to explore the ease of this conversion and the steps required in order to convert existing e-learning content into a format that would operate on a mobile device. To this purpose, the concept of learning objects was used to implement content for mobile learning. Learning objects have the potential to simplify the conversion process by allowing existing materials to be broken down into discrete 'chunks'. Once the appropriate objects had been chosen, the possibilities for conversion were evaluated.

As the project results indicate, the majority of the e-learning content used did not work successfully on mobile devices. The only successful example of conversion of e-learning content to m-learning was one involving a course that had been re-engineered completely to function on a mobile device. However, this kind of conversion can be almost as costly as building a new course from scratch, so it potentially defeats the object of converting existing materials for cost-saving reasons. To achieve cost-saving, one version of the content should function on any device used for access.

Although the results of this research did not meet the initial expectations, the evaluation process and tools used allowed some useful conclusions to be drawn. The actual process that was used offers a framework that could be followed when looking to convert e-learning content for a mobile device. The process allows for the identification of possible problems (eg whether the content is suited to the mobile format) and also identifies potential opportunities that could guide further development of the content for the mobile device.

Keywords
learning objects, m-learning, mobile devices, reuse of legacy content

1 Learning objects

Before any actual substantive evaluation of course content was undertaken, it was essential to establish the parameters for the selection of the content and to understand what a *learning object* is. Many definitions of learning objects currently exist, making the task of defining a *learning object* – for the purpose of reviewing its applicability to support conversion of learning materials to a format suitable for a mobile device – practically insurmountable.

Following a literature review of learning objects, learning object research and the use of learning objects for mobile learning, several different definitions were explored, but all were slightly different. This made the task of selecting a definition to support the main purpose of my research very difficult.

Welsch (2002) discusses the varying definitions of a *learning object* and suggests that it depends on whom you are asking. The research for this project required a definition which offered a basis for deciding how the e-learning content to be reviewed could be broken into more manageable chunks that would potentially be suitable for conversion to function on a mobile device. Consequently, a combination of several definitions appeared to be more suitable for this project than any one definition proposed thus far: some definitions were far too broad and could not therefore make the task of selecting potential objects straightforward; and others were too narrow, which would have excluded some content that had the potential for reusability. The combination of the definitions from Rehak and Mason (2003) and Brown and Hoyle (2003) offered a definition (Rodin 2004) that was succinct, but not too restrictive: 'Discrete elements of learning content that meet a defined learning objective, and are possibly independently assessable, which may take the form of text, graphics, video, stills, animations, diagrams or audio'.

2 Research undertaken

2.1 Research question

The conclusions drawn from the literature review intimated a more fundamental question: are mobile devices suitable for learning purposes? Although the project is not structured to explore this question in great depth, the conclusions of the research outlined below may help to explore some of the issues involved and offer some helpful pointers on the use of mobile devices for learning.

The analysis that was proposed following the literature review offered a focused objective for further research; by applying the concepts of learning objects to existing e-learning courseware, is it possible to migrate courseware to mobile devices? So the research question that was explored can be described as: *in migrating existing e-learning courseware to mobile technologies, can learning objects help?*

2.2 Device and tools used to support the research

With the support of MOBIlearn and Ufi Ltd, 10 pieces of e-learning content were selected for evaluation. The intention was to review the process of converting the materials from a conventional PC-based e-learning environment to a mobile m-learning environment on the HP iPAQ. The reason for selecting the iPAQ was two-fold. First, the iPAQ was equipped with the current standard Microsoft Windows mobile operating system and also appeared to have software available that matched the format of some of the selected materials, such as Macromedia Flash. Second, Keegan (2001), describing the results of an EU-funded project 'From e-learning to m-learning' notes that an iPAQ was cited by learners testing some m-learning applications as their preferred device. It scored highest in nearly all of the evaluation questions, suggesting that it was a more useful and functional device for use in learning than a mobile phone or a Smartphone.

MOBIlearn had also made available several matrices that had been developed to support the division of learning content into learning objects and the elicitation of metadata for the identified objects. The first matrix, the Learning Object Description Matrix, was designed to assist in the process of identifying any potential learning objects. The second, the Metadata Matrix, listed specific potential metadata elements that could describe a learning object, and these elements were developed as a subset of the IMS Learning Resource Metadata, which is now effectively a standard (Mangiavacchi 2003). The subset was agreed by MOBIlearn and included only those pieces of information that were considered to be useful for m-learning. The MOBIlearn matrices were applied separately, as each attempted to support different aspects of learning objects.

2.3 Content review process

By working through the process of converting the content from an e-learning to an m-learning environment for the first piece of content, the various stages of the evaluation process were recorded. The capturing of the flow of tasks enabled a flow diagram to be developed, and this then gave a foundation and framework for the evaluation of the remaining content.

It was crucial to focus the evaluation on the necessary tasks to ensure that there was no deviation from the project plan. Any additional tasks or research that were identified were assessed to establish their appropriateness to the overall research.

If the additional tasks added value to the research, then they were explored on an *ad hoc* basis; if, however, it was decided that no value would be added, the task was recorded along with the reason for the decision not to continue with it.

Seven stages were identified, together comprising the required process for evaluating whether the e-learning content could be transferred to function correctly on a mobile device.

- First, the content was loaded onto a PC and the 'look and feel' explored to identify how it functioned in a conventional e-learning environment.
- The second stage was to evaluate the actual content, identify possible objects, review the structure of the content and the media used, etc.
- The third stage was the application of the MOBIlearn matrices to the content.
- Stage 4 focused on the structure of the content and whether the file directory, coding and design led to the simple elicitation of individual objects.
- Stage 5 comprised the attempt to load the content onto the iPAQ using the Microsoft synchronisation software and any plug-ins that were thought to be appropriate (eg Macromedia Flash 6) if the course was built using this technology.
- The sixth stage consisted of recording any difficulties, observations or suggestions for improvements to the content; if the conversion was successful, the content was tested and its functionality evaluated using a series of set questions to assess the suitability of the content for the mobile device.
- Stage 7 ensured that any outstanding observations or issues were recorded, being intended as a review of the previous six stages. Any final conclusions or thoughts were then noted.

3 Results

The results were divided into each of the seven stages and the content was evaluated at each stage. None of the content that was not divisible into learning objects (as defined previously) would convert to or function on the mobile device. Several pieces of the content that were evaluated had been originally designed to function on a mobile device, or had been specifically re-engineered to function on a mobile device and therefore converted without difficulty. The evaluation of such content was, however, useful to review the suitability of the seven-stage conversion process and also acted as the control content for the experiments.

The first matrix used, the Learning Object Description Matrix, did help with the identification of learning objects, but the Metadata Matrix was not really useful for this research, as it was designed to help in specifying particular metadata for each learning object, and this was outside of the scope of this project.

The results were disappointing in that the only content that successfully and fully converted to function on the mobile device was that designed specifically for mobile devices; the only exception to this rule was a a single piece of content that was, in fact, a video clip that operated through the Windows Media Player software on the PC and the iPAQ.

4 Conclusion and discussion

4.1 The main research

This project has reviewed the current research into learning objects, their use in mobile learning and the use of mobile devices for learning. The substantive research evaluated the potential of converting e-learning course materials, developed for conventional PC-based learning, so that they could function in a mobile environment on a mobile device, the HP iPAQ.

Although the results of this research did not meet the initial expectations, the evaluation process and tools used allowed some useful conclusions to be drawn. The actual staged process that was used offers a framework that could be followed as an initial step when looking to convert e-learning content to a mobile device. The seven-stage process allows for the identification of possible problems, such as whether the content is suited to the mobile format; it also identifies potential opportunities that could guide further development of the content for the mobile device. Following the use of this process, it was found that two of the stages did not generate any tangible results; based on this experience, it may be more appropriate to reduce the whole process to five stages:

- Stage 1: load content into the e-learning environment, evaluate the e-learning materials and attempt to divide into objects
- Stage 2: apply and evaluate the MOBIlearn matrices
- Stage 3: evaluate and review the code, course design and file structures
- Stage 4: transfer the content to the mobile device, evaluate the functionality of the content and apply the test questions
- Stage 5: review the previous stages and record any conclusions or final observations.

The results also demonstrated that the hardware of the mobile device used and the operating system were more specific than first anticipated; much of the difficulty in executing the transferred content was due to software incompatibility. The various plug-ins that were downloaded did help with some of the content, but even these were not as useful as the manufacturers' descriptions suggested. The Macromedia Flash 6 plug-in worked for some of the content, but it was necessary to download a supplementary freeware Flash 6 enhancement (not produced by Macromedia) to add to the functionality of the original plug-in.

When using a mobile device for learning, the context of the content in some circumstances does not support the objectives of the course unless the learner uses the mobile device as an aid instead of a stand-alone tool. For example, there was one course module in which the screenshots and content referred to a different version of the application from that available on the mobile device (Microsoft Word and Pocket Word). In this situation, as the screenshots were designed to give the learner an appreciation of how to carry out various tasks and this did not correlate to the version of the application on the mobile device, the learner could either get very confused and frustrated, or could only use the mobile device as a support tool while practising the application on a PC.

This idea of a support tool to some extent defeats the objective of mobile learning, since to learn from the course, a learner would have to be working at a PC and therefore would not be mobile. However, this does suggest a different use for the mobile device – as a tool to support e-learning, as part of a blended learning approach. This would, however, be an expensive support tool and on this basis is not really practical, as Help programmes already exist in most similar software.

Although the research carried out did not really look at ways that the mobile devices could be used to support learning, some of the content reviewed was structured as small stand-alone units. It can be concluded that this type of content could be used to support a blended approach, allowing a learner to take part of their course with them on a train or bus to browse at leisure.

The screen size of the mobile device could be considered a problem, especially for learners with visual disabilities; however, as all the content evaluated used audio files, some difficulties could be overcome. This suggests that because of the limitations of the size of the mobile device, the use of multimedia, especially audio, is really a necessity to increase the usability of the courses.

4.2 Learning objects – a possible solution

For this project, a definition of learning objects was chosen (see section 1) which was based on an interpretation and understanding of the issues involved. After the courseware evaluation had been conducted, it became clear that this definition was not significantly better in describing a learning object than any of the definitions already described in the literature review.

Nearly all the definitions reviewed attempted to identify an all-encompassing concept of a single learning object. Learning objects are not necessarily isolated pieces of learning material; they are building blocks for e-learning materials and therefore, as with children's Lego bricks, do not necessarily have to come in one shape or size.

During the testing and evaluation of learning materials, it was found that some of the content evaluated was designed using various units that could potentially be considered as learning objects according to the definition used for the purposes of this project (see section 1). They all had similar features, such as an interactive menu, information on the use of the course and use of encapsulated software objects (eg video and audio files). These features are separate from the individual units, and do not represent the content of the course: therefore they could be designed as reusable objects.

These particular objects support the functionality of an e-learning course and consequently support the learning that may take place, so they can be considered as separate software objects that support learning. This description suggests an expansion of the current view of what a learning object is. If a learning object is a building block for constructing an e-learning course, a learning object cannot only be the content within a course, but must be a reusable software object that supports learning.

In conclusion, there is not one type of learning object; instead, a learning object is a software object that can be used to support learning. This also takes the concept of learning objects full circle and allows a course built using this approach to take advantage of all the tried-and-tested developments of object-oriented software engineering, which is a much more established IT field than e-learning and a key contributor to the original development of the learning object concept.

Some learning objects may not be useful in isolation, but metadata can be used to identify the potential use of an object. Using this approach, learning objects can be mixed and matched appropriately.

For example, Netg could create: a single Netg 'menu' object that would ensure that any course developed for Netg will function in the same way; and a single Netg 'help' object that would offer instruction on how to use every Netg course. The Netg developer could, however, also use 'content' objects designed by other e-learning companies and the finished course would not look any different to the learner or customer from any other Netg course. On this basis, the cost benefits are apparent and real interoperability may be possible.

The idea of this learning object model may seem relatively simple, but no definition or approach identified in this research offers the same potential for interoperability, while maintaining control of the finished product for the company or organisation that puts the resultant course together. The various other approaches to learning objects – other than Sloep's (2003) suggestions – arise from the disparate definitions that currently exist. If one definition can permit any organisation to build their own version of a course, and ensure that the objects they use are reused from another source or can be reused to support a different context without any redesign of the original object, then this definition has the potential to become effectively a standard.

Extensible Markup Language (XML) has the potential to support the development of a learning object standard. The use of Scalable Vector Graphics (SVG) and the concepts behind XML could not only make the interoperability of learning objects easier, but also open the door for content to operate on any device, irrespective of the screen size or hardware. Since XML standards exist (albeit currently under review), a learning object standard that standardises the model described above and incorporates the XML standards would make feasible a complete learning object implementation that is fully interoperable.

Sloep's ideas (2003) on a modelling language for learning materials – Educational Modelling Language (EML) – also take a different approach to learning objects. His ideas for the use of EML (which takes advantage of the features of XML) and the separation of the software from the objects is almost the same as that suggested in this paper, in that EML has some objects that represent the materials and some objects to represent the other aspects of a course. The use of EML could enhance even more the model described above and so can be identified as an opportunity for further research.

Functional m-learning products are currently not widely developed and used. The use of the term m-learning is perhaps one of the reasons that interoperability has not yet been fully achieved. If mobile technologies and devices were considered in an integrated approach to e-learning, then some of the interoperability issues might be resolved during the design phase of any e-learning development.

It is essential in software engineering to capture the necessary requirements as early as possible. Current e-learning courseware does not appear to take account of the use of the content on mobile devices; it is therefore likely that such a use was not included in the specifications of the content when it was being designed. As the use of mobile devices – particularly smart mobile phones – is increasing at a phenomenal rate, when a content designer is specifying a new development of e-learning materials, he or she needs to include use on mobile devices within the specifications. In this way, it ensures that the actual use of the materials is irrelevant, whether it be at a desk in a learning centre, at home on a laptop, or on the bus using a mobile device.

References

Brown J and Hoyle D (2003). *Learning objects and materials design*. Unpublished document, Learning Quality and Standards Committee, Ufi.

Keegan D (2001). *The future of learning: from eLearning to mLearning*. London: Taylor and Francis.

Mangiavacchi F (2003). *Sfera metadata*. Unpublished paper written for MOBIlearn Work Package 3.

MOBIlearn (2005). *Website*. At www.mobilearn.org, accessed 10 September 2005.

Rehak D and Mason R (2003). Keeping the learning in learning objects. In A Littlejohn (ed.) *Reusing online resources: a sustainable approach to eLearning*. London: Kogan Page.

Rodin L (2004). *E-learning's little brother: an investigation into current technologies for m-learning, their availability and content design considerations for mobile devices*. MSc thesis: Middlesex University, UK.

Sloep PB (2003). *The language of flexible reuse. Reuse, portability and interoperability of learning content*. Open University of the Netherlands. At www.ou.nl/open/psl/Publicaties/LanguageOfFlexibleReuse2003.pdf, accessed 20 May 2003.

Welsch E (2002). SCORM: clarity or calamity? *Online Learning Magazine*, 9 November issue. At www.onlinelearningmag.com/onlinelearning/magazine/article_display.jsp?vnu_content_id=1526769, accessed 28 May 2003.

Educational content anytime, anywhere on any device

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Abstract

The objective of this paper is to document the work of Intel IT Innovation Centre as related to the skoool* educational initiative, now available in geographies throughout Europe and beyond. This paper combines information from internal sources and respected academics and practitioners in m-learning and pedagogy worldwide. The initial skoool offering is presented, identified limitations are documented, as is the redesign work and innovations that were implemented to address these limitations. Current analysis of the work is documented and recommendations and strategy for going forward are outlined. The paper concludes with a general overview of the future of wireless technology within education and how Intel IT Innovation Centre intends to progress towards the ultimate goal of 'educational content anytime, anywhere on any device'.

Keywords
skoool, peer-to-peer, PDA, Smartphone

1 Background

Intel Ireland, and indeed Intel worldwide, is interested in education and technology in education for a number of reasons.

It is essential to the microprocessor market that new usage models are continually emerging and evolving, and education is among the main drivers in this area. Funk (2004) tells us that as these new usage models mature, and network effects and positive feedback develop, the aim is to reach a critical mass of users. To this end, there is an opportunity to demonstrate the potential of new technologies.

From another perspective, Intel is in a unique position in Ireland to leverage a historically academically strong nation, innovation-friendly government and a talented, educated workforce.

In recent years, there has been a significant decline in students opting for and excelling in the sciences and mathematics in Ireland and the UK. According to Lord May (President of the Royal Society), 'The flow of talent now looks threatened right at the start of the pipeline, in schools. This is particularly true in the physical and mathematical sciences'. It is crucial for a corporation such as Intel that we continually address the requirements for high-level graduates in these areas.

2 Case study – skoool

skoool is the generic project name for an e-learning initiative under way at Intel IT Innovation Centre. The key strategy of this initiative focuses on bringing learning content, interaction, visualisation and real-world application of this knowledge to the learner. It strives to engage the learner and make the learning content accessible through the use of appropriate technologies. The instructional approach taken focuses on where technology can support learners to understand and explore difficult and abstract topics.

Working in public/private partnerships with governments and leading private sector companies, skoool is free to the user and its target demographic is students (12–18 yrs), teachers and parents. It is well established in Ireland and is currently being introduced in the UK [London Grid for Learning (LGfL)], Sweden and other geographies.

2.1 skoool.ie*

skoool.ie was the first-of-its-kind e-learning resource in Ireland when it was launched in 2002. It provides students with curriculum-relevant resources to complement their traditional studies in examination subjects at Junior and Senior Cycle levels, while it provides teachers with high-quality content and tools.

Currently, approximately 80% of all second-level examination students have exposure to the portal.

2.2 skoool.co.uk*

skoool.co.uk was launched in the London Grid for Learning (LGfL) in March 2004. This offering is tailored to the UK curriculum, specifically Key stages 3 and 4 of the science and mathematics subjects. The redesign and innovations incorporated into this offering reflect learnings from our earlier work on skoool.ie. There are channels for teachers and parents which provide support content.

2.3 skoool.se*

skoool.se is a pilot project that has been under way for some months in Karlstad, Sweden. Its purpose is to evaluate the use of rich media e-learning with a view to developing a model that is scalable and extensible across Sweden.

3 skoool: initial challenges

skoool was designed to help demonstrate and drive the adoption of broadband for learning and teaching. However, the roll-out of broadband has been slower than anticipated and this led to limitations being identified in the accessibility and usability of content in the initial product. High-quality courseware was found to be slow on non-broadband connections. In the classroom, it was found inefficient that the portal was accessed by each individual; while in the home, it was considered expensive to stay online for long periods. Significantly, it was also noted that many users were also mobile phone – and to a lesser extent – PDA users. This paper will demonstrate solutions developed to address these problems including peer-to-peer caching technologies and mobile device learning models.

Furthermore, according to Pham, Schneider and Goose (2000), the phenomenal growth of mobile devices and wireless technologies, as well as the need for 'anytime, anywhere' learning, has resulted in a major focus towards mobile and ubiquitous computing. Major technological advancements, combined with the wide range of mobile and handheld devices that are now becoming available at price points feasible for the student/educational arena, make it imperative that we harness these resources and continuously rework our educational approach in delivering pedagogically sound content to skoool users.

4 skoool: initial innovations

To resolve issues identified in feedback and in order to leverage recent technology advancements, a significant amount of redesign and development work has been implemented on selected geographies, while other work is at proof-of-concept stage. Feedback thus far has largely been positive, with some areas identified for further development.

4.1 Introducing myskoool*: high-quality courseware available offline

myskoool was primarily developed to address the issues of low bandwidth, intermittently connected users and multiple users on a local area network (LAN); for example, a school network. Using peer-to-peer (P2P) technology, the user can download the myskoool application, and subsequently courseware, from either the skoool portal or the nearest hosting peer. The courseware may then be viewed offline without the latency associated with a low-bandwidth connection. Also, for a school network, an item of courseware need only be downloaded once – it will then be propagated through the LAN to other users. At home, the user may download a number of courseware items during a period of low internet activity and then use these items offline.

4.2 Content for handheld devices

Work is ongoing in the implementation and prototyping of online and downloadable learning material for handheld devices such as Smartphone and PDA.

Downloadable content

Selected courseware is currently available at www.skoool.co.uk for download to PDA. Proof-of-concept work has been successful for download of content to Smartphone (see **Figure 1** opposite).

Figure 1
Screenshots of Smartphone content

Content is initially downloaded to PC and transferred to the handheld device using integrated infrared or Bluetooth wireless technology.

Online content

Customised online content is available for viewing via Wireless Application Protocol (WAP) and Smartphone.

Types of content for PDA and Smartphone

The learning content for PDA is similar in format and structure to the content on the learning portal. It has, of course, been modified in consideration of the constraints of the handheld device.

The mobile learning content currently available comprises:

- LearnSteps* – instructional learning objects useful for learning and revision
- LearnSims* – simulations allowing the user to interact and apply learning
- Study Notes – reminder or revision tool using primarily text-based content.

SMS Messaging

An SMS messaging facility has been in operation at www.skoool.ie over the last 2 years and has proved very popular with students. The user submits their mobile phone number to the facility on the skoool site and selects their areas of interest; for example, study tips, competitions. Over the course of the school year, a number of SMS campaigns are organised for participating users. To date, examination tips have been the most popular, with 45,000 messages being sent out in May 2004 to Irish pre-examination students. Notification of new content is another way in which this technology is being applied.

5 skoool: ongoing critical analysis

For this project to be a success, Intel IT Innovation Centre acknowledges that it is important to employ an iterative approach to the development of the skoool portal. Design, development and implementation should be followed by feedback and evaluation, leading to further requirements being identified, and thus beginning the cycle all over again. With this in mind, educational specialists within Intel IT Innovation Centre have conducted user surveys and appraisals on work to date. In-depth usage pattern and demographic data is also closely monitored by business and marketing specialists.

5.1 Evaluation findings

A recent evaluation of the skoool.co.uk portal, conducted in May 2004, made the following conclusions with respect to handheld device usage.

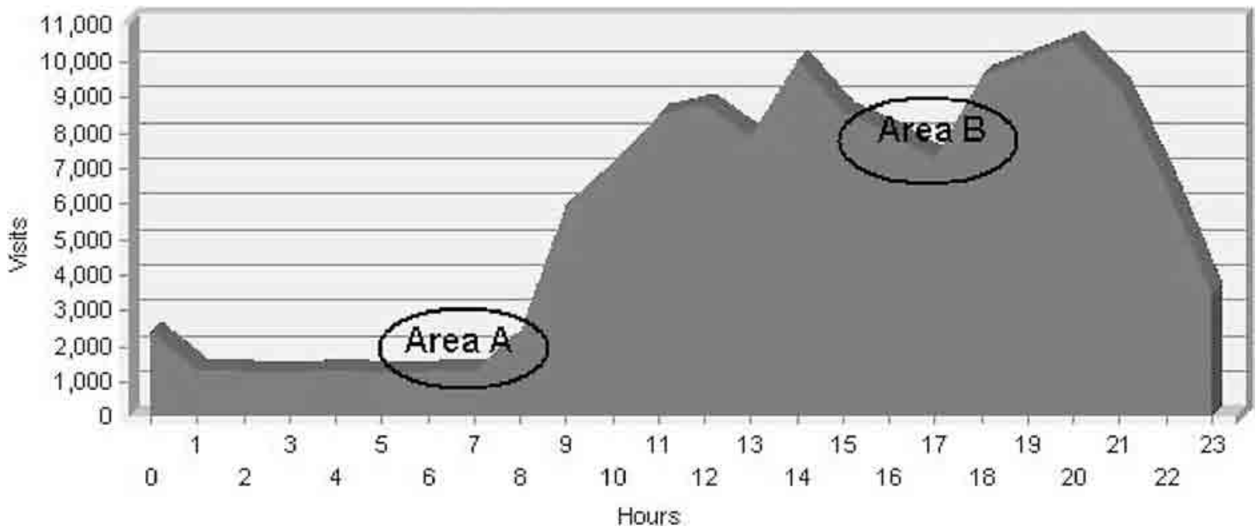
Content

- Very clear benefit to learners that there is a portion of the portal devoted to m-learning.
- The content provides the learner with a lot of useful information that is well structured, clear and pedagogically sound.
- The content provided leverages mobility and interactivity through the use of simulations.
- Progress can still be made in leveraging other key benefits of the mobile device. Not enough opportunity currently exists for the learner to engage in the creation of ideas and knowledge.
- The integration strategy allows the user to have a similar learning experience to online while mobile.
- Examination Centre content may need to be made more concise – presently too wordy.

Devices

- The handheld device is currently being used primarily as an administration and organisational tool, rather than a tool to support learning.
- Navigation and readability on devices were rated as OK.
- Survey respondents suggested that the mobile device lends itself to reflection, exploration and instruction in that order.

Figure 2 Activity level by hour of day (averaged over week)



5.2 Usage statistics

As shown in **Figure 2**, our experience with skoool clearly indicates that there is a strong demand for quality technology-based learning 24 hours a day, 7 days a week. Widespread use of mobile devices will extend this potential significantly further.

The proliferation of mobile devices will surely increase usage throughout the day, but especially at peak times when students are 'on the move' on their way to or from school or on field trips or research work (Areas A and B in **Figure 2**).

6 skoool: strategy for going forward

Based on our experience of developing the award-winning learning service www.skoool.ie and more recently www.skoool.co.uk, Intel IT Innovation Centre has researched, experimented with and developed a wide range of learning approaches for advanced handheld computing devices. The question we must ask is, 'Which horse to back?' Technology adoption has always been a highly unpredictable phenomenon with two highly unpredictable vectors: timing and direction. Based on this uncertainty, we have chosen an options-based approach, developing learning technologies for a range of devices and connection models.

6.1 Which learning and technology models will prevail?

The notebook computer remains the most powerful and flexible computing and learning device. The PC is the workhorse platform for myriad tasks including report writing, research, data analysis and the use of advanced multimedia learning resources. Mobility is key, with the proportion of notebook computer purchases continuing to increase and Wi-Fi technology capabilities now included as standard.

With this as a given, we see a model where users utilise a range of low-cost handheld devices that integrate with and work alongside the laptop, which sits at the centre of these devices and acts as a hub, collecting and distributing data from these devices and the internet.

The devices will include:

- Tablet PCs
- handheld PDAs
- multimedia-enabled Smartphones
- digital still and video cameras
- MP3 music players
- digital gaming devices.

Connection models will include fixed and wireless internet, wireless mobile phone connection, synchronisation facilities and Bluetooth and infrared connections. Occasionally, connected models will continue to be employed where users take advantage of high-speed connection at hotspots and transfer data as appropriate to other devices for offline usage.

6.2 A design recommendation for future mobile device learning

There are two aspects to such a design recommendation; how best to use the device as a learning tool based on its capabilities; and what support context would best support this design.

Based on the evaluation work outlined earlier, our educational specialists propose an outline design focusing on the constructivist principles of reflection and collaboration. The core capabilities of the mobile device identified to support this design are mobility and capability to share information.

The mobile device as a reflective and collaborative tool

Much of the curriculum-driven learning in class is based on instruction and to varying degrees, encourages a behaviourist approach to learning and teaching within the classroom. With the proposed design, the mobile device would be used to support reflection and collaboration, allowing learners to build their own understanding of a topic, thus encouraging constructivist thinking.

The reflective component of the design would include worksheets based on semantic organisation tools such as a concept-mapping tool designed to help learners analyse and organise information. Nesta Futurelab (2004) has shown that the effectiveness of computer tools in such scenarios appears to be enhanced when used by learners in pairs or in groups. In line with this, the collaborative aspect of the design is based around learners sharing worksheets and conducting peer reviews of each other's work.

Furthermore, the design proposes that learners may upload their reflective and learning contributions to a collaborative area on an online learning portal for use and development by others. This would leverage the capabilities of both the PC and mobile device and, as Bransford, Brown and Cocking (1999) outline, this could result in an 'intellectual partnership with the computer in that the whole of the learning becomes greater than the sum of the parts'.

7 Looking to the future

7.1 The digital home/school/office

The arrival of the pervasive digital media environment in the school, home and office seems imminent. The key factors contributing to this include:

- wider availability of broadband
- increased interest in home networks
- increased sophistication of personal digital devices
- ever increasing libraries of digital content.

According to Otellini (2004), this will herald a new era of consumer electronics that will be 'equally exciting to the rise of the PC'. The success of new consumer devices will hinge on some key attributes, including:

- Wi-Fi (wireless connectivity)
- Veri-Fi (security capabilities to safeguard consumers' data)
- Hi-Fi (high-quality)
- Ampli-Fi (the ability to move data across networks)
- Simpli-Fi (intuitive user interfaces).

Though his comments were made in relation to the digital home specifically, it is worth considering them in the context of the school environment and projecting how they will apply in that setting.

7.2 The mobile internet

Mobile computing has taken major steps forward with the wide adoption of Wi-Fi, Intel® Centrino™ mobile technology and the upcoming WiMax technologies. However, mobile internet services over next-generation networks have been relatively slow to gain ground in Europe and the US when compared to Japan and Korea.

Among the reasons for this, argues Funk (2004), are:

- The mobile Internet is more disruptive for Western firms than for Japanese and Korean firms.
- Western firms focus more on business users than their Japanese and Korean counterparts, while the market for the mobile internet seems to be young users.
- The creation of a micro-payment system by NTT DoCoMo* for its i–mode* service, which made it easier for content providers to collect revenues, thus increasing the amount of content available.
- Higher subsidies are being paid by Japanese firms to retail outlets to sign up new subscribers.

Whatever the reasons, bearing in mind that success in Japan and Korea is clearly due to young users, it would be wise to learn from their success and plan on how this technology can be leveraged in education when it gathers momentum in Europe.

Some of the findings thus far include:

- Young people are the initial users.
- PC internet penetration is not related.
- Ringtones and screensavers are the initial market.
- A micro-payment system is needed for content.
- We should not over-hype the mobile internet.
- The mobile internet, whether based on WAP or cHTML, is a superior technology to SMS.
- The mobile internet is not just a service – it is a new network industry requiring service, content, software providers and device manufacturers.

8 Conclusion

In this paper, we have looked at the skoool project and the iterations that it has been through to date in the pursuit of delivering media-rich content tailored appropriately to the users for its intended geography. We have examined the different models of delivery available currently and have anticipated what these may be in the future and how best we can use them.

Successes and failures identified thus far have been presented in an effort to share knowledge and thus increase overall learning. This, we believe, is the best strategy for moving forward.

References

Bransford JD, Brown AL and Cocking RR (eds) (1999). *How people learn: brain, mind, experience and school*. Washington DC: National Academy Press.

Funk JL (2004). *Mobile disruption: the technologies and applications driving the mobile internet*. Hoboken, NJ: John Wiley and Sons, Inc.

Hamilton P (2004). Personal communication. Intel IT Innovation Centre.

Kynäslahti H and Seppälä P (eds) (2003). *Mobile learning*. Helsinki: IT–Press.

Nesta Futurelab (2004). *Literature review in thinking skills, technology and learning*. At www.nestafuturelab.org/research/reviews/ts01.htm, accessed 21 June 2004.

O Donovan A (2004). Personal communication. Intel IT Innovation Centre.

Otellini P (2004). Intel enters a new era of consumer electronics. In *Proceedings of Consumer Electronics Show*, Las Vegas, January 2004.

Pham TL, Schneider G and Goose S (2000). A situated computing framework for mobile and ubiquitous multimedia access using small screen and composite devices. In *Proceedings of the 8th ACM International Conference on Multimedia*. New York: ACM Press.

Blended learning, mobility and retention: supporting first-year university students with appropriate technology

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Abstract

This paper describes how Short Messaging System (SMS) was identified and used as a form of 'mobile scaffolding' in an experiment to support first-year university students, addressing issues related to supporting student retention. The research and issues underpinning the rationale for the experiment are summarised, including new data related to types of messaging technology used by students. Results from the experiment are presented. The paper concludes with a discussion of issues raised, including the surprisingly low rate of student participation in the evaluation process.

Keywords
blended learning, student retention, mobile learning, e-learning

1 Introduction

UK universities are increasingly concerned with issues of student retention (EESC 2001; May and Bousted 2003) and in the light of the UK government's policy aims of having 50% of school leavers attending university by 2010 (Sutherland 2002), the different routes that students can take to achieve this will increase. The corresponding increase in diversity of backgrounds and experiences will have an impact on the demands for retention support (Cox and Bidgood 2002). At the same time, there is a continuing increase in the deployment of e-learning tools and strategies in the university sector.

2 Background

Grounded Theory research was undertaken at Kingston University into student perceptions of the benefits of e-learning (Alsop and Tompsett 2002). Key themes identified included some which were less to do with technology or tasks, and more to do with students' notions of time and space. The same technique was proposed as suitable for identifying the means by which students use communication technologies to collaborate (Stone, Alsop anf Tompsett 2003); this was tested by asking a group of 20 second-year students to undertake an exercise which described a good and bad experience '…of using communications to collaborate and work in groups'.

SMS and Instant Messenger (IM) applications polled the same amount of 'good' responses (50%), with e-mail and face-to-face communication mentioned equally as secondary modes. However, the most frequently mentioned technology in relation to 'bad' experiences was e-mail (40%), followed by face-to-face communication (25%) and voice calls (20%). Core concepts have been identified as based on issues of time, location and effective communication. Given the (current) reliance on fixed connections for IM communication between students (it could be argued that the distinction between SMS and IM will blur as mobile handset capabilities evolve), it was felt that this exercise highlighted the potential for using SMS to support students as a complementary technology to those in use by learning providers at this time.

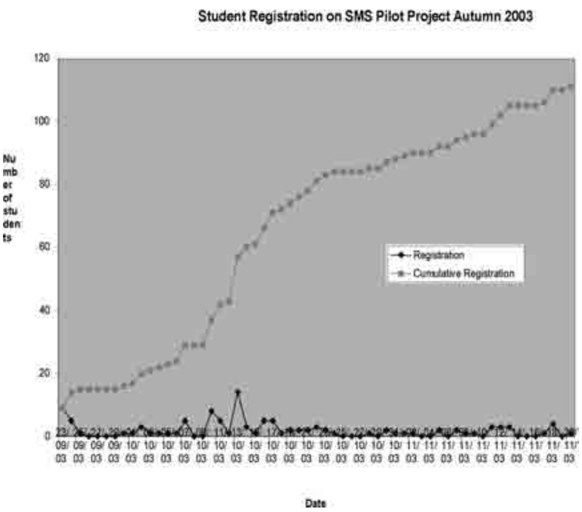
To further test this hypothesis, a survey group of first-year students was asked if they would be interested in SMS services to support them. Without exception, all students said they would be interested in using such a service (Stone 2004). Furthermore, the types of service they expressed an interest in were consistent with other studies (Divitini, Haugalokken and Norevik 2002; Lehner and Nosekabel 2002), as well as findings from work done in parallel on student retention across Kingston University as a whole (May and Bousted 2003).

3 The experiment

Having identified candidate services and technologies, an experimental SMS service was offered to first-year students to support them on one of the core modules in the first semester. It was publicised in many ways during the start of the degree programme: during induction-week lectures; at the start of the module; and by announcements made via Blackboard, the learning management system (LMS) currently used at Kingston University. Although it was an entirely voluntary (opt-in) process, 115 students registered within the first 6 weeks. The nature of the messages changed over the course of the semester: from timely, relevant information provision ('where and when'; see **Figure 1**) to SMS 'tips' on where to find information within the e-learning system and elsewhere.

Figure 1
SMS alert received by student

Figure 2
Student takeup of SMS over time



It was noticed that student registration with the SMS service took place over a longer time period than expected (see **Figure 2**). There is evidence that supports two hypotheses as to why this was so:

- the role of peer recommendation through social interaction and usage
- shared experience of a technical issue (a prolonged network outage on campus), which made further benefits of the SMS system apparent to students, as the two main formal conduits for information dissemination (ie Blackboard and the university e-mail system) became inoperable and inaccessible for several days.

4 Feedback and discussion

Feedback was requested through e-mail questionnaires. Students were requested in lectures, via announcements on Blackboard and via SMS to complete these. The number of responses was disappointingly low (only seven were received), but this has been experienced elsewhere (Baty 2003). Nevertheless, there were some questionnaire responses that are consistent with informal responses given by students in face-to-face encounters.

Students believed that they came to be aware of the service more via Blackboard than through lectures, with reminders for deadlines (particularly on assessments) being the main reason. This type of SMS message was also found to be the most useful to students, closely followed by notification of changes. Given the problems experienced with Blackboard, it is reasonable to speculate that this acted as a driver for students to use the trial service in the absence of any formal online information provision system (be it e-mail or Blackboard).

When asked what services they would have liked to have seen, notification of updates on Blackboard was the most popular, closely followed by a roll-out of the pilot service to all first-year modular courses. There was also a request made for notification as to how to collect marked coursework from the departmental offices for the first time. Since some of the early coursework for the module in the experiment fed into subsequent assessments, it was felt that this should have been done so that students were given start-to-finish support for their first piece of assessed work.

There is some evidence to suggest that students do share the information that was relayed to them at short notice via SMS, but in a variety of ways. They are just as likely to inform their peers face-to-face as they are by a voice call or SMS. Due to the low number of respondents, it is not felt that this result can be used in isolation. However, from this and informal face-to-face conversations with students, it would seem useful to bear in mind that there are a variety of modes of communication that can be (and are) used by students to communicate with their peers. This should be remembered when considering novel support mechanisms, particularly where technologies may be thought of as able to replace, rather than complement, existing modes of communication. As indicated above in section 2, the need for 'appropriate technology' for the individual student, rather than 'information technology' for an assumed, homogeneous set of users, is something which ought to inform designers of blended learning strategies.

Finally, although students expressed a unanimous interest in using a full implementation of the pilot service, those against any form of payment for the service are in a 2:1 majority, with many comments alluding to the expectation that universities should offer such support free of charge. In addition to this expectation, concerns also exist in the minds of students about issues of security and trust (Carroll and Hartnell-Young 2004; Sørensen 2004). These are issues which would have to be resolved if such a service were to develop into a fully operational support system for students.

References

Alsop G and Tompsett C (2002). Grounded Theory as an approach to studying students' uses of learning management systems. *Association for Learning Technology Journal*, 10(2), 63–76.

Baty P (2003). Student survey plans falls apart. *Times Higher Education Supplement*, 21 March.

Carroll J and Hartnell-Young E (2004). *Available just enough: the mobile phone as a safety net for parents and their teenage children*. Paper presented at The Life Of Mobile Data: Technology, Mobility and Data Subjectivity Conference, University Of Surrey, 15–16 April.

Cox B and Bidgood P (2002). Widening participation in MSOR [Mathematics, Statistics and Operational Research]. *MSOR Connections*, 22(1). At http://ltsn.mathstore.ac.uk/newsletter/feb2002/pdf/widening.pdf

Divitini M, Haugalokken OK and Norevik P (2002). Improving communication through mobile technologies: which possibilities? In *Proceedings of the IEEE International Workshop on Wireless and Mobile Technologies in Education*. Ltechnology in relation to 'bad' experiences was e-Alamitos, CA: IEEE Computer Society Press, 86–90.

Lehner F and Nosekabel H (2002). The role of mobile devices in e-learning – first experiences with a wireless e-learning environment. In *Proceedings of the IEEE International Workshop on Wireless and Mobile Technologies in Education*. Los Alamitos, CA: IEEE Computer Society Press, 103–106.

May S and Bousted M (2003). *Retention project final report*. Unpublished internal paper, Kingston University, UK.

EESC (2001). *Higher education: student retention*. Sixth Report of the Education and Employment Select Committee, UK Government. HMSO.

Sørensen C (2004). *Research issues in mobile informatics: classical concerns, pragmatic issues and emerging discourses*. Paper presented at The Life Of Mobile Data: Technology, Mobility and Data Subjectivity Conference, University Of Surrey, 15–16 April.

Stone A (2004). Mobile scaffolding: an experiment in using SMS text messaging to support first year university students. In Kinshuk, C-K Looi, E Sutinen, D Sampson, I Adeo, L Uden and E Kähkönen (eds) *Proceedings of the 4th International Conference on Advanced Learning Technologies*. Los Alamitos, CA: IEEE Computer Society Press, 405–409.

Stone A, Alsop G and Tompsett C (2002). Grounded Theory as a means of user-centred design and evaluation of mobile learning systems. In *Philosophy, Psychology, Education*. Vienna: Passagen Verlag.

Sutherland J (2002). University challenged. *The Guardian*, Monday 22 July.

Wolcott LL and Betts KS (1999). What's in it for me? Incentives for faculty participation in distance education. *Journal of Distance Education*, 14, 34–49.

HistoBrick: utilising J2ME to enable students to use mobile phones for game-based learning on descriptive statistics

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Abstract

Based on preceding work on a mobile learning scenario, a Java 2 Platform, Micro Edition (J2ME)-based game-like application, called HistoBrick, is being designed. It serves as a platform for exercises, assignments and self-study in combination with the higher education (HE) courseware on descriptive statistics. This paper focuses on the mobile application and ignores its embedding into a suitable learning management system (LMS). HistoBrick aims to provide a ubiquitous tool for learning about distributions and their most important characteristic numbers. The didactical background is inspired by recent ideas about how learning works in the so-called constructivist setting, in general; and by the findings of game-based learning, in particular.

Keywords
mobile learning, edutainment, J2ME, game-based learning

1 How can edutainment promote mobile learning?

The evaluation of a mobile course on descriptive statistics (Ströhlein 2003; Ströhlein and Fritsch 2003) revealed that students appreciate the ubiquitous access to remote communication provided by mobile phones and their relatively long battery duration period. Recent mobile phone models can display a variety of document formats and have considerable computing capabilities as well: thus, they are an interesting tool for course authors, learners and tutors.

Students considering the use of a mobile phone for learning purposes are typically thinking of learning while riding on a bus or train or while spending their spare time in public places; thus they will easily be distracted. But a game-like mobile learning application can create the necessary 'grip' to attract a student's attention completely: this is a main precondition for effective learning, and hence one reason to develop an edutainment application. The final evaluation phase of the HistoBrick application (eg Meier and Seufert 2003) in 2005 will include a check on whether the other effects of game-based learning predicted by its advocates (eg Prensky 2000, 2001, 2003, 2004) are actually felt.

Another reason why a game-like scenario has been chosen to encourage students to reach their learning objectives – even in a subject that has a reputation for dealing with 'dry numbers' and being 'boring' – is a change in attitude towards learning during the last few decades. If these young people are to be enticed to spend more time on learning instead of listening to music or talking with friends, the courseware has to capture them with some fun, at least. The same psychological principle induces pharmacists to add a sweet taste to cough mixtures.

Of course, this game-like application has to be able, for example, to handle the small screen size of a mobile device and the possibly bumpy conditions in a train or bus. This is why devices that can be operated using the fingers of only one hand seem more suitable for playing HistoBrick than those requiring a stylus. When students are travelling on a train or the underground/metro or spending their spare time in modern buildings made of ferroconcrete, they have unreliable access to a mobile network or even none. Consequently, HistoBrick is designed mainly for offline usage; but when a sufficiently strong mobile network power signal is available, students may exchange information with their peers or tutors; for example, to submit results or receive new exercises.

2 **Brief description of HistoBrick**

The main purpose of HistoBrick is to enable students to develop and deepen their knowledge of the relation between (the shape of) a distribution and its most important characteristic numbers; that is, mean and standard deviation as well as all quartiles. By creating suitable sets of exercises to be solved within HistoBrick, tutors can guide students to experience the flaws and fallacies that occur if the characteristic numbers are dealt with without having a look into the data. This means that the application is based on a so-called constructivist didactic (eg Thissen 1997).

2.1 Technical background

In order to keep the effort required to create and maintain HistoBrick to a reasonable level, a cross-platform and cross-device language have to be used for coding; in this project, Sun's J2ME (Java 2 Platform, Micro Edition) has been chosen. J2ME provides ways to establish HyperText Transfer Protocol (HTTP) connections in order to contact other students or the tutor. These connections also enable the use of media – pictures, music or video – for communication or when the tutor wants to reward a student for a successfully solved exercise. It is recommended that the mobile device has a colour screen of at least 4k depth and 128x128 (WxH) pixels resolution.

The 'number crunching' capabilities of the manufacturers' implementation of Sun's J2ME platform differ considerably from phone to phone, according to the versions of both the Connected Limited Device Configuration (CLDC) and the Mobile Information Device Profile (MIDP). The latest phones come with CLDC 1.0 and MIDP 2.0 and a few have begun to implement CLDC 1.1 and MIDP 2.0. HistoBrick is going to depend on MIDP and CLDC Java classes only, so that it is highly portable. Even a moderately complicated mathematical formula for calculating standard deviations requires a floating point number format, which fortunately has been introduced in CLDC 1.1. Because all variable values are integers in HistoBrick and thus can be processed by CLDC 1.0-enabled devices, a version that deals only with all quartiles is being developed and tried out first. The improvements that MIDP 2.0 adds in terms of security, networking and gaming features strongly recommend its usage for the realisation of HistoBrick. One of the first phones in the shops in Germany that is shipped with the combination CLDC 1.0/MIDP 2.0 and which most students can afford is the Sagem myX–7, from which the screenshots in this paper are taken.

2.2 Features and design of the game

The game aspect of HistoBrick is created by the fact that students have to direct an automatically 'falling brick' into one of eight boxes (see **Figure 1** opposite). The aim of the game is to create a distribution of 'bricks', the characteristic numbers of which meet predefined target values as closely as possible. These target values can be self-defined, chosen randomly, or provided by the tutor or other students via a suitable channel of communication, the design of which is subject to ongoing research. At present, the preferred solution is to use HTTP connections between phones and the application web server together with server-side scripting, as this allows students to use relatively cheap General Packet Radio Service (GPRS) volume tariffs. An alternative would be to use the relatively expensive Short Messaging System (SMS) or Multimedia Messaging System (MMS) for direct communication between phones.

The text language of HistoBrick can be chosen from a screen which automatically appears and displays all available languages; though at the moment, only German and English are implemented. Selecting a language automatically brings up the main menu, which provides access to all the important features of HistoBrick – start a game with randomly chosen conditions; load, set, save or send game conditions; display the instructions or additional information; and finally, exit the application. The receipt of values from other students or the tutor is handled in the 'load game' sub-menu.

The top area of the game screen (see **Figure 1** opposite) is used for initially placing the 'bricks' and moving them into the boxes drawn below by pressing the corresponding buttons. The boxes area shows a diagram indicating how many 'bricks' have already been directed into all the eight boxes; and the feedback area at the bottom of the screen shows two indicators: the upper one corresponds to the characteristic numbers of the distribution that has actually been created; and the lower one corresponds to their pre-set target values. In the top left corner, the overall number of 'bricks' and that of the one that is just falling are indicated numerically in order to notify a student how carefully a 'brick' has to be placed.

During a game, approximately three times per second, a 'brick', which is depicted as a small square and initially appears at the very top of the screen, is automatically moved a small way towards the boxes. In each step, by pressing the appropriate button or pushing the mini-joystick of the mobile device, a gamer is able to choose to direct the 'brick' to the left or right, to move it directly into the box below its actual position, or to interrupt the game for about 2 seconds to adjourn for further thought. If a gamer is required to stop the game due to environmental influence (eg background noise, unexpected movement of the device, incoming call), pressing the appropriate menu key of the device stops the game and lets the main menu appear on the screen to save the actual boxes' scores and pre-set values into the persistent memory of the mobile device, if wanted. The game conditions are automatically saved when a call comes in.

The colours of the game screen are chosen carefully. In order to indicate the close relationship between (a) the 'bricks', (b) the bars showing how many 'bricks' are found in the boxes and (c) the indicator of the characteristic numbers of the bricks' distribution just below the boxes, only one colour (blue), is used for all of them. The indicator of the pre-set characteristic numbers uses a second colour (red). Both indicators use two levels of colour saturation: the range corresponding to the measure of spread is indicated using half saturation, and the position of the measure of location is indicated using full saturation. The background, the box walls and all scales as well as additional information are painted in different saturation levels of grey and black. The saturation level of the box walls is chosen so that they do not visually interrupt the shape of the bricks' distribution bars, but are clearly visible above them (see **Figure 1**). This is important because on the one hand, the shape and the indicator form the very part of HistoBrick that is most important for the learning process; and on the other hand, the upper ends of the box walls have to be clearly perceptible in order to permit a 'brick' to be easily moved into the chosen box.

Figure 1
Screenshots of Histobrick as displayed on the Sagem myX–7

3 Future prospects

After coding and thoroughly testing all offline features, the online features like sending and receiving game settings will be created. The next step is to identify an open source LMS that can easily be adapted for use with mobile handheld devices. After the necessary changes have been applied to the LMS, the mobile courseware will be evaluated with first-year students at several different universities. Then didactic issues can be addressed too; for example, whether the horizontal starting position of the 'bricks' should be chosen randomly instead of keeping it fixed; if the Central Processing Unit (CPU) of the mobile device is powerful enough; whether a demo mode could be added to create model distributions. Another idea is to use 'bricks' with a different 'weight' in order to let students get a broader sense of how distributions evolve in reality.

References

Meier C and Seufert S (2003) (in German). Game-based learning: Erfahrung mit und Perspektiven für digitale Lernbeispiele in der betrieblichen Bildung. [Game-based learning: experience with and prospects of examples of digital learning in workplace education.] In A Hohenstein and K Wilbers (eds) *Handbuch E-Learning (Ergänzungslieferung)*. [Handbook of e-learning (additional material).] Köln: Fachverlag Deutscher Wirtschaftsdienst.

Prensky M (2000). *Digital game-based learning*. McGraw–Hill.

Prensky M (2001). Interview with Prensky on game-based learning. At http://elearningpost.com/elthemes/prensky.asp, accessed June 2004.

Prensky M (2003). *But the screen is too small…* At www.marcprensky.com/writing/Prensky%20-%20But%20the%20screen%20is%20too%20small.pdf, accessed June 2004.

Prensky M (2004). *Use their tools! Speak their language!*

At www.marcprensky.com/writing/Prensky-Use_Their_Tools_Speak_Their_Language.pdf, accessed June 2004.

Ströhlein G (2003) (in German). Bericht über Entwicklung und Erprobung eines Kurses für mobiles Lernen. [Report on development and try-out of a course designed for mobile learning.] In K David and L Wegner (eds) *Mobiles Lernen und Forschen*. [Mobile learning and research.] Kassel: Kassel University Press.

Ströhlein G and Fritsch H (2003). *Test and evaluation of a course designed for mobile learning*. ZIFF Papiere No 120. Hagen: FernUniversität.

Thissen F (1997). *Inventing a new way of learning? Constructive fundamentals of a multimedia teaching methodology*. At www.frank-thissen.de/Inventing%20a%20New%20Way%20of%20Learning.pdf, accessed June 2004.

Evaluation of the technical and pedagogical mobile usability

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Abstract

The major goal of the multidisciplinary Digital Learning 2 project is to develop an online tool to evaluate the usability of digital learning materials. This paper concentrates on describing the technical and pedagogical usability criteria and how they are specified in order to take account of the special features of mobile learning materials and environments. This was done by incorporating a 'components of mobile learning' (CML) evaluation model, which had been previously developed and empirically tested, into the criteria, after reviewing the other earlier categorisations for evaluation of mobile learning.

Keywords
evaluation, mobile usability, pedagogical usability, technical usability

1 Introduction

The multidisciplinary Digital Learning 2 (DL 2) research project, which started in 2001, has members from the research fields of education, computer science and hypermedia. The major goal of the project is to develop a tool to evaluate the usability of digital learning materials and environments. In order to reach that goal, numerous concepts and models have been defined; for example, the criteria for technical and pedagogical usability and the Components of Mobile Learning (CML) model.

The following components of the *technical usability criteria* were specified (Nokelainen 2004):

1. accessibility
2. 'learnability' and memorability
3. user control
4. help
5. graphical layout
6. reliability
7. consistency
8. efficiency
9. memory load
10. errors.

In addition, the following *pedagogical usability components* were specified (Nokelainen 2004):

1. learner control
2. learner activity
3. cooperative learning
4. goal orientation
5. applicability
6. effectiveness
7. motivation
8. valuation of previous knowledge
9. flexibility
10. feedback.

The Components of Mobile Learning (CML) model was developed for evaluation of mobile learning. The model (Ahonen *et al*. 2002) consists of:

1. continuity and adaptability
2. learning as a personal process
3. contextuality in learning
4. accessibility
5. support for time and learning management
6. flexible interaction.

From these criteria, we derive the questions that are presented to the user when he or she is evaluating mobile learning material or environments. The purpose of the evaluation tool is not to classify evaluation targets as 'good' or 'bad' ones, but instead to show in an understandable manner some of the design principles and goals behind the evaluation target. There are at least two explicit ways to use the tool: first, to evaluate any given system or learning material by means of a self-report multiple-choice questionnaire; and second, to seek for other users' evaluations of learning systems or materials.

The criteria for evaluation of the technical and pedagogical mobile usability have been developed in the following stages:

- investigation of the previous research reports dealing with the characteristics of mobility and mobile learning (2001–2002)
- development of the first version of the CML model (2002–2003; Ahonen *et al*. 2002)
- development and empirical testing of the criteria (2003; Syvänen *et al*. 2003, 2004)
- review of earlier categorisations for the evaluation of mobile learning and incorporation into the technical and pedagogical usability criteria (2004).

2 Evaluation criteria

The incorporation of the criteria for evaluating mobile learning into the original technical and pedagogical usability criteria was done after the review of earlier categorisations for evaluation of mobile learning (see **Table 1** opposite).

The degree of sensitivity in the different criteria components for an evaluation of mobile learning is presented in **Table 2** (overleaf).

Table 1 Summary of the earlier categorisations for evaluation of mobile learning

Technical

Öquist, Goldstein and Chincolle (2004) *Factors of mobile usability*	Luff and Heath (1998) *Types of mobile collaboration*	Sharples (2000); Sharples, Corlett and West-mancott (2002) *Tools for lifelong learning*	Vavoula and Sharples (2002) *Requirements for lifelong learning organisers*
Portability	Micro-mobility	Highly portable	Easily transferable between places
Attentiveness	Local mobility	Individual	Available and functional at any time
Manageability	Remote mobility	Unobtrusive	Smooth transition between learning topics and construction of meaningful, integrated knowledge
Learnability		Available	
		Adaptable	
		Persistent	
		Useful	
		Easy to use	

Pedagogical

Kynäslahti (2003) *Elements of mobility*	Perry, O'Hara, Sellen, Brown and Harper (2001) *Properties of technology supporting mobile workers*	Savill-Smith and Kent (2003) *Why use palmtop computers for learning?*	Gay, Rieger and Bennington (2002) *Levels of objectives: mobile computers in education*
Convenience; rationality	Lightweight and highly flexible	Relatively inexpensive	Productivity
Expediency	Allows more effective planning of activities and flexible allocation of resources	Possibility of ubiquitous computing	Flexible physical access
Immediacy	Supports effective use of 'dead time' to plan for upcoming mobile activities and catch up with non-mobile work	Access to information and information literacy	Capturing and integrating data
Quality of life	Allows the use of location and access to locally available resources	Possibility of collaborative learning	Communication and collaboration
	Allows monitoring of remote activities more easily	Possibility of independent learning	

Table 2 Evaluation of mobile learning materials and environments
Numbers in this table relate to the numbered lists of criteria in section 1

Technical		**Pedagogical**	
Component	*Questions for the user relating to mobile material*	**Component**	*Questions for the user relating to mobile material*
1 Accessibility	Manageability	2 Learner activity	How personal are the learning products?
2 'Learnability' and memorability	Cross-platform use	3 Cooperative learning	Flexibility in collaboration
3 User control	Attentiveness	5 Applicability	Support for contextual use Attentiveness
6 Reliability	Offline use		
7 Consistency	Cross-platform use	6 Effectiveness	Added value of mobility
8 Efficiency of use	Manageability	8 Valuation of previous knowledge	Continuity of learning process
9 Memory load	Attentiveness		

3 Conclusions

In this paper we have specified the criteria for evaluation of mobile learning material in detail and shown how mobile learning materials and environments are evaluated with an online evaluation tool. The real-life empirical testing of the evaluation tool was difficult to conduct as at the time, there were only a few learning materials or environments defined solely for mobile use. However, the progress of developing such materials all over the world is rapid, and thus we see the mobile evaluation criteria as a meaningful part of the evaluation tool. In the future, we intend to develop the evaluation tool through empirical testing of real-life mobile learning materials and environments.

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References

Ahonen M, Koponen H, Syvänen A and Turunen H (2002) (in Finnish). *New mobile innovations supporting learning*. Digital Learning 1 project. Saarijärvi: Häme Polytechnic and University of Tampere.

Gay G, Rieger R and Bennington T (2002). Using mobile computing to enhance field study. In T Koschmann, R Hall and N Miyake (eds) *CSCL 2: carrying forward the conversation (computers. cognition and work)*. Mahwah, NJ: Lawrence Erlbaum Associates Inc, 507–528.

Kynäslahti H (2003). In search of elements of mobility in the context of education. In H Kynäslahti and P Seppälä (eds) *Mobile learning*. Helsinki: IT–Press, 41–48.

Luff P and Heath C (1998). Mobility in collaboration. In *Proceedings of the ACM Conference on Computer Supported Collaborative Work, Seattle, 14–18 November*. New York: ACM Press, 305–314.

Nokelainen P (2004). Conceptual definition of the technical and pedagogical usability criteria for digital learning material. In *Proceedings of ED–MEDIA 2004: World Conference on Educational Multimedia, Hypermedia and Telecommunications, Lugano, Switzerland, 2004(1)*, 4249–4254.

Öquist G, Goldstein M and Chincholle D (2004). Assessing usability across multiple user interfaces. In A Seffah and H Javahery (eds) *Multiple user interfaces*. Chichester: John Wiley and Sons, 327–372.

Perry M, O'Hara K, Sellen A, Brown B and Harper R (2001). Dealing with mobility:

understanding access anytime, anywhere. *ACM Transactions on Computer–Human Interaction*, 8(4), 323–347.

Savill-Smith C and Kent P (2003). *The use of palmtop computers for learning. A review of the literature*. London: Learning and Skills Development Agency 2003. At www.m-learning.org/docs/the_use_of_palmtop_computers_for_learning_sept03.pdf, accessed 20 January 2004.

Sharples M (2000). The design of personal mobile technologies for lifelong learning. *Computers and Education*, 34, 177–193. At www.eee.bham.ac.uk/sharplem/papers/handler%20comped.pdf, accessed 20 January 2004.

Sharples M, Corlett D and Westmancott O (2002). The design and implementation of a mobile learning resource. *Personal and Ubiquitous Computing*, 7(6), 220–234. At www.eee.bham.ac.uk/sharplem/Papers/mobile%20learning%20puc.pdf, accessed 20 January 2004.

Syvänen A, Nokelainen P, Ahonen M and Turunen H (2003). Approaches to assessing mobile learning components. In L Mason, S Andreuzza, B Arfé and L Del Favero (eds) *European Association for Research on Learning and Instruction. Abstracts of the10th European Conference for Research on Learning and Instruction*, Padova, 581.

Syvänen A, Nokelainen P, Pehkonen M and Turunen H (2004). Mobile learning future views. In *Proceedings of ED–MEDIA 2004: World Conference on Educational Multimedia, Hypermedia and Telecommunications, Lugano, Switzerland, 2004(1)*, 2112–2118.

Vavoula G and Sharples M (2002). Requirements for the design of lifelong learning organisers. In S Anastopoulou, M Sharples and G Vavoula (eds) *MLearn 2002: Proceedings of the European Workshop on Mobile and Contextual Learning, Birmingham, 20–21 June*, 23–26.

A mobile interactive guide to the Museo Diocesano di Catania: how to 'open' the Museo using PDAs

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Abstract

This paper describes the way that handheld devices are used as multimedia guides in the Museo Diocesano di Catania (Italy). Particular importance was given to designing these devices and their contents so that they would allow for an extended visit, going beyond the Museo's contents and covering more general topics that are related to the exhibits.

Keywords
church museums, PDA, beni culturali ecclesiastici

1 Do we really need a multimedia guide?

Visiting a museum is an enriching experience, which involves different levels of perception, from the aesthetic and emotional to the rational and cognitive. Indeed, one can enjoy a masterpiece at an aesthetic level only, being emotionally involved in what the artist shows and suggests. It is expected, however, that a museum visit could draw more widely on visitors' knowledge and promote a deeper interest in the items they look at, leading them to read and study further on the topics shown in the exhibit or related to them.

Often 'lesser' museums prove to have stimulating and exciting contents. The Museo Diocesano di Catania is a place where visitors can find out about the many different ways of expressing religious feeling across the centuries, and learn about the history of Catania and the devotion attributed to Sant'Agata, the patron saint of Catania.

The extensive printed explanations that complement exhibits develop cross-cultural themes and give a large amount of information on the works on display. However, for practical reasons these explanations are outside the glass cases of the exhibits, far away from the pieces they refer to. References to single works of art are sometimes not so easy to understand, and are usually made by describing or referring to the object using a number. Users have to make a considerable effort if they want to interpret and understand the items on display.

Audio guides have become increasingly widespread recently. These guides let you listen to a recorded voice that explains the objects. To refer to a specific section of an exhibit, you have to key in a number or you follow a predefined path along which there are 'listening points', usually identified by an icon. These vocal guides are not too flexible and make it difficult to define a customised path during a visit: the risk of losing the correlation between the recorded voice and what you are looking at is very high.

2 The device

To address these problems we have designed a multimedia guide that instead of simply supplying a recorded description allows for deeper interaction and the display of text and pictures to supply further information on the works in the exhibit. The devices most suited for this purpose are the new generation PDAs, equipped with an operating system Pocket PC 2002, with a 64k colour depth display and good resolution (320 x 240 pixels).

These tools allow visitors to widen their visit beyond the museum walls. They supply information about exhibits in a way that is easier to understand and customised to individual users when they want it. These two features are the key difference between multimedia guides and conventional printed explanations about exhibits. Now it is possible to make it easier to understand any work of art on display, by combining text, pictures and audio.

All the information about the Museo is loaded into the device memory, which is large enough to contain a wide set of multimedia contents, suitable for exhibits larger than those held by the Museo di Catania. The continuing reduction in the cost of memory and the increasing size of memory available makes this possible.

The PDAs are equipped with a web browser that displays HTML pages. A player is installed in order to allow for the reproduction of Macromedia Flash movies. This solution enables existing technologies to be used. Texts are displayed as HTML files that embed compressed images (GIF or JPEG). Audio is controlled and played using the Macromedia Flash player, which allows for a very high compression in MP3 format, without compromising quality. The audio is played through a small loudspeaker embedded in the device for small groups, or could be reproduced using headsets from the standard connector provided.

The guides are rented at the museum entrance where tickets are sold. They are optional and a small additional fee is charged.

3 The man–machine interface

We have adopted a very simple and conventional form of interaction, placing value on the usability of the multimedia guide, not on fancy but useless features, such as animation or jingles. The hierarchical menu on the guides mirrors the Museo's structure and lets visitors access the explanations of the various rooms during the visit, either in the natural sequence in which they are encountered or according to an order defined by users themselves, according to their interests or preferences.

Visitors use the tactile screen and stylus to operate the guides, which allows for a very high pointing precision. During the usability tests we assessed that this style is a much more natural way of interacting with devices than the mouse. Even users who are not accustomed to new technologies have found it intuitive and easy to use.

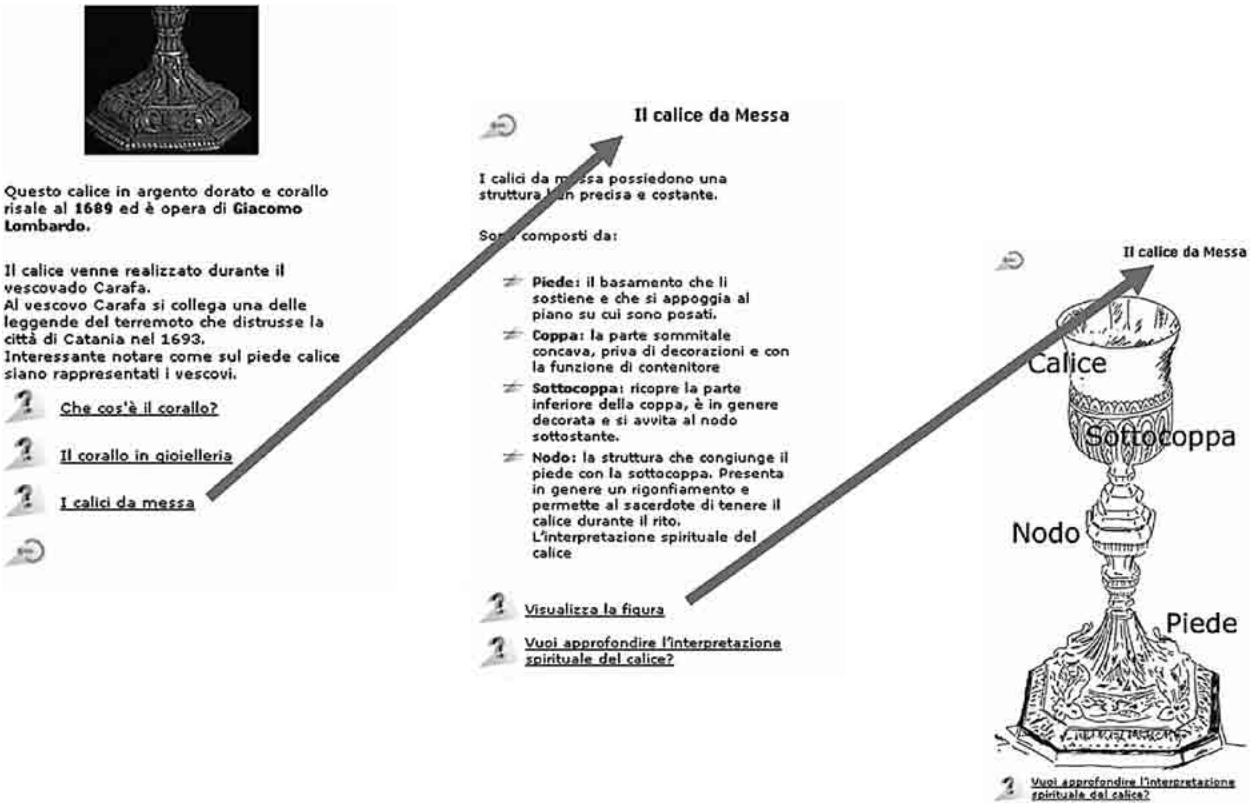
4 Contents

The multimedia guide in this very first version describes only a small number of the objects displayed in the Museo, but gives users information about all the Museo's rooms. There is a floor plan of the Museo's rooms, with zoom-in functionality and easy identification of the works of art displayed; this lets visitors identify at a glance what is most relevant for their interests.

The page structure is kept as simple as possible. At the top of the page there are only two icons. One can be used to navigate back to previously visited pages; the other one turns the audio voice-over on or off. The text contains a number of hyperlinks to navigate among the topics supplied in a non-sequential way. For instance, from the S. Cataldo reliquary you can access pages on reliquaries in general and those with human body features, and can get more information on the works of Paolo Guarna, the author of S. Cataldo reliquary. In a similar way, the painting of the miracle of S. Isidoro Agricola is linked to other works by different painters on the same topic, which can be found at the Prado Museum in Madrid, Spain.

The multimedia guide particularly addresses the worship of S. Agata. The museum contains several items related in some way to the worship of the saint, but they cannot easily be understood by visitors who haven't been at the February celebrations to honour the saint. The bare *fercolo*, on display in Room IX, for instance, is enlived by the description of its use during the celebrations of S. Agata as supplied by the multimedia guide.

Some themes that are outside the scope of the museum but strongly related to some of the items on display are developed in further detail. For instance, the guide contains a detailed description of the symbolic meaning of chalices used during the Mass (see overleaf), supplied by Professor Pfeiffer of the Pontificia Università Gregoriana in Rome.



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References

Fantoni, S F. *Museums with a personal touch*. At www.ecdc.nl/publications/papers/Museums%20with%20a%20personal%20touch.pdf

Marucci, L and Paternó, F (2001). *Design and evaluation of an adaptive virtual guide for web applications*. Pisa: CNUCE–C.N.R.

Sakamura, K (2003). *Personalized digital museum assistant*. At www.um.utokyo.ac.jp/dm2k-umdb/publish_db/books/dm2000/english/01/01-17.html, accessed 5 May 2003.

The shift to seamless augmentation and 'humane' applications via mobile/wireless devices: a view to a future for lifelong learning

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Abstract

With the approach of endless bandwidth and increasingly powerful CPUs, we are overcoming limitations to producing 'the perfect content'. This is a period wherein computation, communications and interfaces are becoming 'transparent' elements of our mobile lifestyle. It is also a period when applications will take on an increasingly 'humane' identity – reflective both of the need to address directly mounting societal problems such as unemployment, educational failures and mental illness; and of Englebart's 1965 vision for justifying the PC as 'an augmentative' filter in service to evolving humanity. In evaluating the capacity for mobile/wireless devices to augment more important parts of our lives, I have chosen to focus on developing career-centric evaluation tools for phones/PCs, and share 10 design epiphanies I have evolved for developing more socially valuable applications across mobile/wireless devices.

Keywords
augmentation, lifelong learning, social and emotional Learning

1 The approach of pervasive interactive communications

1.1 Unlimited bandwidth/Mhz

With the approach of endless, affordable bandwidth and low-power, high-yield CPUs we are overcoming the limitations to producing pervasive interactive communications, devices that are perceived as intimate and 'trusted', and 'the perfect content' for fulfilling any task.

The result is a fundamental shift in our ability to produce software and services that not only support lifestyle and quality of life, but also are optimised for addressing real problems in our lives and society such as unemployment, educational failures and mental illness. Why not consider a greater focus on developing applications that are more 'humane', given both the immeasurable harm that unemployment plays on attitude and economic development, and given the fact that 1–5% of most populations suffer from mental illness – much of which is addressable via timely communications with an expert?[1]

Of course, choosing to develop software that uses popular mobile devices to address issues as personal as our survival and existence is fraught with critical challenge. Applications developed to assist with our mental health would be more problematic than, say, delivering language learning, music, sports and the news. Moral mandates, societal values and legal liabilities cloud one's ability to develop applications that might assist individuals across diverse cultures.

Yet the notion of evolving truly 'augmentative' software that increasingly and effectively addresses our higher order needs is not only exciting, but inevitable. It is a vision that now seem not only unstoppable, but in some thoughtful ways worthy of acceleration – particularly within the more broad content scope of 'lifelong learning'.

2 At least one future for lifelong learning: career counselling

When one thinks of education – whether classically or virtually – one may typically think of the classics (mathematics, science). But what of the less than classical types of 'attitudinal' learning referenced above such as curriculum specific to counselling and coaching? Considering current challenges such as:

- the high number of unemployed
- the social, emotional and economic impact of this status on individuals and their families and society
- the availability of electronic and human resources to assist in the process of re-careering
- the unique and trusted capacity of mobile devices to provide access to their resources.

I have chosen to commit my energy in service to developing career counselling and augmentation software. I have begun this campaign with the development of a 'mythological evaluation tool' that enables the unemployed make a better selection of an ideal career path based on an overarching 'narrative' analysis of their aggregate careers.

2.2 Ten design epiphanies

In developing my emerging process I have evolved 10 design epiphanies reflecting my 20 years of experience as a digital producer of educational, entertainment and enterprise applications which I share in this document. Particularly germane to this notion of more 'humane' applications, these 10 considerations should enable designers to create mobile and wireless learning applications of particular meaning and value to their targeted user base. They are as follows:

1. Commence all designs with a 'top 10' list of innovations you hope to bring to market at the time of launch; this strategy will assist in the positioning, marketing and promotion of your solutions to consumers, distribution partners and the press.
2. Remember that despite their appeal and obvious value, 'm' ('e' and 't') learning benefit from the value of relationship-based 'scaffolding' germane to conventional learning environments (see prolearners.com); reintroduce peer-oriented group interaction into the mix.
3. Consider that 'attitudinal learning', the fifth of Gagne's learning taxonomy (motor skills, verbal skills, problem solving, higher order thinking and attitudinal learning), remains the most neglected in the classroom, workplace and home – and is perhaps the most required in service to solving many of today's greatest economic and social problems.
4. Increase your focus on aggressively cross-disciplinary research (eg technology plus social sciences), out of which entirely new domains of socially valuable applications and services innovation will emerge – particularly as communications infrastructure evolves towards toward maturity and ubiquity.
5. Reflect that the primitive, one-off user profiling now conducted sporadically by retailers will give way to ever-aggregating, lifelong client 'profiling', providing ever richer, seamless and pervasive means by which to identify, offer and deliver educational, cultural, economic and psychological value.
6. Reflect that we are 'just in time' centric – driven primarily by the immediate relevance of any challenge or opportunity to our core needs, this insight suggesting that 'profile-driven' solutions will emerge as mainstream.
7. Believe that mobile phones and their ever-more intelligent offspring are likely to emerge as the primary 'client' for all humans within five to seven years – our primary interface to the world's aggregate data-based wisdom.
8. Remember that the inevitable algorithmic growth of product and services capacity (Moore's Law) continues at a consistent pace, suggesting ever-receding technological limitations – and ever more unlimited capacity to implement organic processes that mirror human intelligence and emotions in service to ever more compelling interfaces and engines.
9. Remember the foundational vision of Douglas Englebart, father of the mouse, and co-father of the modern PC. In 1965 he envisioned a day when personal computing technology would evolve as the basis for assuming 'augmenting' our quality of life by taking responsibility for 'lower level needs' such as computation, storage and so on, so that our quality of experience as humans could evolve.
10. Please remember that the things the consumers – all humans – really care about will always remain the same: health, knowledge, self-esteem, friends, love and home.

I share the above design epiphanies with the intent to encourage more of us to develop ever more humane and compassionate services and applications that are truly relevant to all of our needs as happy, healthy and effective humans.

Endnote

1. *International Herald Tribune*, 3 June 2004, 5.

Mobile learning – the ethical and legal challenges

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Abstract

Mobile learning using handheld computers, smartphones and dedicated gadgets, often with the added functionality of text and picture messaging, built-in cameras and location-awareness, presents a variety of technical and pedagogic opportunities and challenges to educators and developers. These are becoming understood and mobile learning is slowly making the transition from small-scale short-term trials to sustainable institutional embedding. This process implies a continued need to explore appropriate methods for evaluation.

This paper looks at the ethical foundations of such evaluation and at the ways these new technologies impact on how we can monitor and evaluate in ways that are legally, socially and culturally acceptable.

The paper sets out some current trends in ethics in the transition from codes to principles and frameworks, and explores how this affects the delivery and evaluation of mobile learning.
It also looks at the relationship between philosophical perspective and practical ethics as they affect critical issues in evaluation such as informed consent.

Keywords
ethics, evaluation, monitoring

1 Introduction

The issue of ethics influences mobile learning at two different stages. The first is that evaluating mobile learning trials requires ethical consideration. The second is that any ongoing online activity, including mobile learning, has an ethical dimension and this needs to be identified and explored as mobile learning evolves. In the first instance the responsibility is of the evaluator or researcher for the research participant. In the second, it is of the teacher for the learner.

In both, the idea of ethics encompasses a spectrum from statutory issues to cultural issues, from what is defined as legally acceptable to what is defined as socially acceptable. Ethics is a significant issue because evaluation and provision that do not conform to explicit ethical guidelines may be:

- seen as improper or immoral
- breaking laws or regulations
- unacceptable to the research community.

There are however a number of potential problems in attempting to develop ethical guidance for mobile learning.

- The ethics of computer-based and remote online research, including evaluation, with participants are still immature and untested.
- Online learning, including mobile learning, could take place in several different countries and consequently across different legal jurisdictions.
- Online learning, including mobile learning, might be working with participants whose ages are near the legal age of majority (and this age may vary from country to country).

2 Ethical principles

Many professions and bodies attempt to give ethical guidance to their members and quite a few of these would be relevant to the practitioners of mobile learning. There are bodies for learning technologists, educational researchers and software developers, and for academics within universities. Each offers some ethical guidance to practitioners. In some fields there has been a change of emphasis from codes to principles (eg BACP 2002). This allows ethical practice to be proactive and responsive to context or situation. It may then match progress in pedagogy and technology, rather than being merely reactive and always pursuing events.

Significant ethical issues and ethical differences may not be raised, discussed or resolved because they are ‘taken-for-granted’ or conversely considered ‘not worth mentioning’. Ethical frameworks are often assumed and therefore obscure (Warner 2004).

At a rather more theoretical level, ethics can be based on divergent philosophical foundations that take, for example, different positions on ‘reality’, knowing and the self. A simple division can be made between modernism, with its confidence in the ability of scientific method to give access to a pre-existing reality, and postmodernism, which is far more sceptical about such ‘truth claims’, believing instead that reality is continuously and collaboratively constructed.

Within a modernist framework the researcher strives for objectivity. Engaging in postmodern research involves researchers reflexively asking why they are doing this research in this way, what is it silent about, what gives it authority, and who is privileged by it?

These apparently recondite issues can make a profound difference to practical ethics, as we shall see when we look at the topic of ‘informed consent’ in a later section.

3 Ethics: the mobile learning dimension

In order to consider the impact of mobile learning on the ethics of evaluating educational provision, it is easiest to start with models of ‘pure’ mobile learning. We can then move on to the more likely forms of provision, those involving mobile learning blended with other, more conventional or traditional formats and media. In this sense, ‘pure’ mobile learning means learning delivered solely by mobile technologies.

The major ethical issues in relation to the evaluation of ‘pure’ mobile learning include informed consent (and participant withdrawal), anonymity and confidentiality, participant risk, payment to participants and cultural differences (Anderson and Kanuka 2003, Hewson *et al*. 2003).

3.1 Informed consent

Informed consent is a core ethical issue for research and evaluation. It refers to participants’ understanding of the nature, extent, duration and significance of their involvement with the research.

Returning to issues of underlying philosophy, where truth is problematised informed consent cannot be straightforward, so for postmodernists it can never be total.

The research process is complex and dynamic and as such cannot be simply represented to participants. Data can take us in unexpected directions, which the participants have not given prior consent to (Weatherall, Gavey and Potts 2002). The binary division between researcher and researched is seen as problematic especially with regard to privilege and power. Consequently, there is more likely to be an ongoing process of negotiating issues of informed consent. From a realist position, giving information required for informed consent may influence the responses given and so ‘contaminate’ the data.

In conventional learning, informed consent might be achieved by a face-to-face briefing or written outline with the opportunity for follow-up questions. This briefing or outline might cover the aims and objectives of the research and then issues such as anonymity and confidentiality, parental permission, participant risk, withdrawal, remuneration and so on. Participants then have the chance to express their consent by signing a consent form.

For ‘pure’ mobile learning, this is potentially problematic for the following reasons.

- It may be difficult to explain fully the scope of mobile learning in a succinct and appropriate fashion in a way that is consistent with mobile learning itself.
- Participants may only engage in mobile learning via SMS or VoiceXML, where there are very few precedents for gaining and signifying informed consent.
- A mobile learning system may not preserve persistent learner identities across sessions or across devices, thereby possibly confusing the source of consent and the data to which it relates.
- In any remote research, it is easier to deceive researchers and evaluators. Any internet-based or online researchers have no reliable face-to-face cues.
- There may be insufficient means for would-be participants to check their understanding of the research and their part in it.
- Only participants who understand the nature of their participation can legally grant consent. In mobile learning, it may be difficult to establish whether this is the case without face-to-face contact.
- Expressing consent, especially in a legally significant fashion, usually requires a conventional written signature.

- Informed consent assumes that any information or explanation on which the consent rests is expressed in a fashion that is inclusive of varied literacy, linguistic and physical abilities (and accords with the provisions and spirit of SENDA and comparable national legislation).
- Accidental or deliberate personation is always possible.

Existing practice

Existing practice in relation to obtaining informed consent can come from a variety of internet-based evaluation and research formats, as follows.

- *Obtaining consent for e-mail interviewing*: the explanatory briefing is mailed or e-mailed to participants, or they are directed to the project website; their consent is e-mailed back or printed, signed and faxed or posted back.
- *Obtaining consent for conferencing*: the explanatory statement is posted in the conference; participants then post or e-mail queries and then signal consent as above.
- *Obtaining consent for chat*: is real-time and so informed consent is problematic. An asynchronous area may be used in parallel to engage in the consenting process.
- *Obtaining consent for participant observation*: mail lists, news-groups and so on present possibilities for undisclosed but problematic participant observation – so-called 'virtual ethnography' (Hine 2000), there is a consent issue.
- *Collecting personal electronic documents*: there is a consent issue, one also associated with harvesting system data on users' behaviour.

However, the issue of informed consent is apparently less legally problematic than it might appear since mobile learning trials only run the risk of participant withdrawal (rather than litigation) and could easily put itself in a position where participation implied consent. The involvement of minors in research or evaluation does not, in fact or in practice, require parental consent as long as the participants are sufficiently mature to understand the nature of their participation. So-called minors give their de facto consent to all sorts of transactions in everyday life without needing to refer to their parents. In each case, the issue is whether their majority is sufficient to comprehend the implications of the specific transaction in question.

3.2 Participant risk

Mobile learning trials pose risks to participants insofar as they may inadvertently expose participants to unsafe or unsavoury behaviour or material via various media, from external web-based sources and from other participants. Participants should be aware of the nature and extent of this risk, and so especially should the parents or guardians of any under-age participants. Risks might include access or exposure to harassment, abuse, 'spam', hate mail or unsafe internet sites. It is clearly the duty of researchers and evaluators to shield participants from harm and to minimise its consequences.

Some forms of mobile learning encourage or allow peer-to-peer collaboration. This raises the possibility that participants may be exposed to risks, for example obscene picture messaging, over which the organisers cannot possibility have any control but for which they might nevertheless still be legally responsible.

3.3 Participant withdrawal

Internet-based procedures should make withdrawal easy at any point. Researchers and evaluators are clearly interested in keeping participants live within the trials and there is some tension between these two considerations.

3.4 Payment or compensation

In much research or evaluation work it is understandable that participants are recompensed for the time or effort of their involvement. This establishes some kind of 'contract' between them and the researchers and thus raises two kinds of issue. The first issue is methodological and in essence is the question of whether payment or compensation has skewed or contaminated any results or conclusions. The second issue is ethical and concerned with whether the compensation can be viewed as fair or equitable for the time or effort involved. Issues related to differentials in culture, status and power may obscure easy access to answers about whether the 'contract' is actually perceived as fair by participants, especially the learners themselves and possibly also host organisations in the field. Where benefits are tangible, the relationship is legally contractual but if participants are merely being recompensed or the benefits are intangible, this is probably not the case in law.

3.5 Confidentiality and anonymity

Researchers and evaluators are expected to guard the anonymity of research participants in any published accounts. There are routine practices for this in conventional research. In purely virtual or online learning, this may not be an ethical problem since participants' real identities and attributes could be wholly fictional. Such an eventuality would however be a considerable methodological problem. Researchers must also guarantee the confidentiality of any data from or about participants. In large and complex mobile learning consortium projects with many people, partners, intermediaries, components and devices this is potentially problematic legally.

Some researchers (Buchanan 2004) have pointed out the inherent contradiction, when quoting respondents verbatim, with acknowledging their copyright while preserving their anonymity.

A different issue involving privacy is the extent to which some mobile learning technologies reveal data about individuals that they might not know was accessible. Some devices are location-aware and disclose the participant's movements.

3.6 Private and public distinctions

There is an increased need in online interaction to distinguish whether the participants regard online exchanges and interactions as public or private. This is relevant to e-mail, mailbases, newsgroups, chat, forums and so on since the distinction can become blurred or forgotten or the interaction can quickly move from the public to the private. This is possible in mobile learning sessions.

3.7 Roles: researcher, teacher, organiser, manager

Similarly, there is a need to maintain distinctions about roles. A mobile learning project worker may have more than one role in relation to participants, most likely developer, teacher/lecturer (with pastoral and academic responsibilities), evaluator and researcher. These roles have different and possibly conflicting ethical requirements and responsibilities and hence it is important for participants to understand the context for any given interaction.

3.8 Status and power

Researchers and research organisations, in this context universities and colleges, must recognise that any interactions with participants, including gaining and maintaining informed consent, take place across myriad differentials in status and empowerment, for example between learner and teacher, or learner and researcher, and so on. These differentials are related to positions within organisations, within social structures, within society itself and within the education system. They pose ethical and methodological problems, which may be at odds with each other. Feminist research in particular has been at pains to tease out the consequences of these issues for participant research and to develop appropriate methodologies. Some of this thinking has informed research with online communities.

3.9 Cultural differences

Many evaluations take place across cultural (or sub-cultural) divides where various parties may be dissimilar in terms of language, expectations and values.

This will be true in mobile learning where the participants are culturally and ethnically diverse, usually young, and often economically exposed and possibly close to 'street' culture, while the mobile learning researchers, usually university lecturers, will be party to rather different types of discourse and expectations.

3.10 Developing effective debriefing

Researchers and evaluators are obliged to ensure that participants are unharmed at the conclusion of their involvement with research and, to this end, debriefing procedures are often established. These procedures might provide debriefing text with contact details and invite comments and queries. This may be relatively lightweight but mobile learning evaluators should nevertheless consider some mechanism to conclude participants' involvement and give 'closure'. Many researchers make their interpretations available to participants (often called 'member checks'); this may or may not be part of the informed consent process. For modernists it is likely to be seen as increasing accuracy, whereas for postmodernists it may be to allow a more collaborative or co-constructed process, to give greater credence to previously excluded 'voices' and to respond to challenges regarding responsibility in representing the 'other'.

3.11 Netiquette

Each new network communications technology evolves its own specific cultural expectations governing interactions and exchanges broadly termed 'netiquette'. Currently the most obvious of these govern e-mail, chat and conferencing:

- E-mail netiquette includes emoticons and 'smileys', a relaxed attitude to grammar and spelling and the expectation of brevity.
- Chat netiquette includes expectations about inappropriate 'ringing'.

Conferencing (and Usenet, mailbase and so on) netiquette often has published codes of behaviour precluding, for example, 'spam' and flaming. Mobile learning will have a variety of channels, some equivalent to existing ones identified above and some completely novel, such as SMS texting. For each one, teachers and learners will need some initial guidance while intrinsic or indigenous ethics and etiquette are developing.

A rather different perspective on the cultural expectations governing interactions and exchanges comes from the growing literature (Katz and Aakhus 2002) that looks at the ways in which mobile devices, usually mobile phones, are redefining judgements about aspects of interaction in public spaces. In some respects, mobile phones enable users to define private spaces and private interactions in hitherto public spaces. Mobile learning will inherit these changed attitudes and perhaps define spaces for learning that had not previously existed.

4 Conclusion: the practicalities

In practice of course learning will almost always be delivered by a blend of mobile and conventional technologies and consequently some or all of the difficulties associated with 'pure' mobile learning will not arise.

The use of mobile learning to supplement or enrich mainstream campus-based learning in colleges and universities is probably ethically unproblematic.

Distance learning is perhaps the most ethically problematic of the standard formats used in universities and colleges, especially if students are dispersed and geographically remote. Similar issues may arise with part-time students at a distance, particularly if mobile learning is only blending with online learning.

5 References

Anderson T and Kanuka H (2003). *E-research – methods, strategies and issues*. Boston, MA: Allyn and Bacon.

BACP (2002). *Ethical framework for good practice in counselling and psychotherapy*. Rugby: British Association for Counselling and Psychotherapy.

Buchanan, E (ed). (2004). *Readings in virtual research ethics – issues and controversies*. London: Information Science Publishing.

Hewson C, Yule P, Laurent D and Vogel C (2003). *Internet research methods*. London: SAGE Publications.

Hine, C (2000). *Virtual ethnography*. London: SAGE Publications.

Katz JE and Aakhus M (eds). (2002). *Perpetual contact – mobile communications, private talk, public performance*. Cambridge: Cambridge University Press.

Warner S (2004). Contingent morality and psychotherapy research: developing applicable frameworks for ethical processes of enquiry. *Journal of Critical Psychology, Counselling and Psychotherapy*, 4(2), 106–114.

Weatherall A, Gavey N and Potts A (2002). So whose words are they anyway? *Feminism and Psychology*, 12(4), 531–539.

Implementing mobile technology as part of the multimode (blended) teaching and learning academic strategy @ the Tshwane University of Technology

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Abstract

In the light of the increasing need for higher education, recent technological developments, and the vast and logarithmic developments in all disciplines, this research reports on the outcomes of an implemented mobile technology project and provides some guidelines for future development and implementation of mobile technology at the Tshwane University of Technology (TUT). Emphasis is placed on the lecturer as primary educator, and the student as learner, as well as on the responsibility they both have in the educational process. Acceptance of this responsibility demands thorough introspection and a re-engineering of the teaching, learning and technology processes at the TUT. This results in a new teaching, learning and technology strategy wherein the roles of the lecturer and student change. In the changed roles, the lecturer and the student are managers.

The lecturer accepts responsibility for teaching and the student becomes his or her own learning manager. The WWW, WebCT as our learning management system (LMS) and a PDA (our mobile device) were the main instruments in stimulating student self-activity.

The paper addresses:

- the changed role of lecturer and student in a new educational model
- teacher centred instruction vs student centred learning
- the value of mobile technology
- the outcomes of the nature conservation m-learning project
- some criteria for m-learning to be successful and to create a lifelong learner (and lecturer!)
- training, motivation and support for faculty and students
- the instructional design process.

Keywords
mobile learning (m-learning), blended learning, mobile technology, lifelong learning (LLL), instructional design, web-based instruction, learner centred learning, learner managed learning, multimedia

A study of mobile learning as part of everyday learning

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Abstract

Mobile learning as a concept has come about through the availability of mobile technologies. A number of questions about the phenomenon of mobile learning are raised: how does mobile learning integrate with other learning activities? When in the day does it happen and where? What does it relate to? What portion of everyday learning does it constitute? This paper outlines the first stages of an investigation aimed at addressing these questions through a study of everyday learning episodes.

Keywords
mobile learning, everyday learning, diary-based study, learning episodes

Introduction

Mobile learning as a concept has come about by virtue of the availability of mobile technologies such as mobile phones and handheld computers. New learning practices are emerging, such as bitesize revision and just-in-time learning. Unlike more traditional forms of learning, mobile learning has not so far been studied as a phenomenon in the world; rather, it has been introduced as a new technology-led practice that will potentially lead to new learning phenomena. The research reported in this paper aims to fill in this gap by studying the conduct of mobile learning in relation to everyday learning. The study is currently being undertaken as part of the MOBIlearn project at the University of Birmingham.

Study methods

The aim of the study is 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. A diary-based method of recording data has been adopted for the purposes of the study and participants are asked to keep a diary of their everyday learning episodes. The diary is available as a paper template, as a desktop application, or as a set of web-based forms. All three formats have the same structure. The participants are required to fill in, for each learning episode, information about:

- *temporal context*: the date; the time span during the day when the learning took place; and its duration
- *social context*: the other people who were involved in the episode and the roles they assumed
- *situational context*: the location and event during which the learning episode took place
- *educational context*: any learning method that was employed; the forms of assessment applied; the purpose, if there was an explicit purpose; what was learned in relation to what it was originally intended should be learned; and the area in life to which this episode relates (work, hobbies, community work)
- *activity context*: the learning topic; the kind of support that was available in terms of help from other people, printed or online manuals and other resources; the different activities that were performed; the different resources that were used; the problems that arose before, during or after the episode; and any greater learning project that this particular episode related to
- *historical context*: other activities, not directly related to the learning, that were performed just before, during and immediately after the learning episode, to capture how learning interleaves with other, everyday activities.

The instructions encourage the participants to report all their learning episodes, irrespective of whether they are mobile or not, so that we can infer what portion of everyday learning is mobile. To characterise a learning episode as mobile, we will use the situational and activity context data; episodes that involve the use of mobile computing or communication technologies, or which take place away from a fixed environment such as a person's workplace or home, whether or not mobile technologies are involved, will be characterised as mobile.

The study has begun and will continue until the end of the MOBIlearn project in December 2004. Initial data has been collected and is being analysed, the results of which will be presented at the conference.

Using mobile phones and pocket PCs for creating, delivering and retrieving content on the fly, based on mobile web browsers

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Abstract

Students use mobile devices to document the heritage. Once documented they use their phones to upload the information to the e-guide using an application based on a phone web browser – Nokia 3650, Nokia 6600 and Ericsson P900 were used in the exercise. Documenting the heritage was a combination of using GPS, vector maps, satellite photos, phones supporting a web browser, GPRS network and an application that connect the existing e-guide (www.chimer.org) with the new information.

Keywords
mobile, children, CHIMER, 3G

CHIMER phone web browser platform

The Chimer Project (www.chimer.org) developed and implemented applications for mobile technologies in a cultural heritage environment. Children from different educational areas – from rural schools of Spain where mobile networks are the only network available, Chanovice in the Czech Republic, Bad Doberan in Germany, Vilnius Lithuania and Den Helder in Holland – are using this platform for content creation on the fly in real time using mobile devices such as Nokia 3650, Nokia 6600, Ericsson P900 and pocket PCs. Device portability is a key point in the CHIMER Project.

The information can not only be created but be retrieved through any pocket PC, tablet PC and the new generation of Ericsson, Samsung and Nokia 60 series of Java-based mobile phones. Video, audio, photos, text, vector maps, routes and satellite images can be retrieved.

The information is connected to a geographic information service (GIS) based on Flash technology that enables users to interact in real time with vector and satellite images, and associate information with any point of the map.

Besides the map and the information is an open platform enhancing the competence of children in the use of leading technology and communication systems, in order to create, search and modify networked information resources. They can share, explore and exploit their local cultural heritage with children from other European countries. Educational and museum experts have provided the information to the children while teachers worked to coach children to research the problem of content creation using mobile tools.

The project is seen as a task force that is being used to solve a problem. In one way CHIMER is a multinational company operating in different countries in its mission to document the heritage through mobile technologies. It creates a critical mass of information to help identify the problem it has in documenting the heritage.

The project is fully operational on GPRS, WIFI and UMTS platforms. It has been successfully tested in different environments and is working at 100% capacity.

This paper will show how to create content using mobile devices, and how to upload and retrieve the information using an application based on a phone browser using a GPRS connection in roaming. A live demo will be conducted during the conference, which will allow participants to create their content on the fly, upload it and retrieve it with any phone that supports a web browser.

References

Weiss D (2003). *The summer school book*.

Weiss D (2004). *Chimer goes mobile*. At www.cultivate-int.org/issue8/chimer/

International Workshop on Mobile Learning for Emergency Management (MLEM) papers

A mobile first aid training system for training doctors in stabilising casualties on site

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Abstract

In major emergencies, the medical team is moved to the site of the emergency instead of waiting for the casualties at the casualty ward. Ensuring fast treatment in administering first aid and stabilising the casualties before they are transported to the hospital is of major importance for saving lives. A system for training doctors for such situations has been developed and implemented on a PC. The system will allow the doctor to make use of equipment that is accessible from a handbag that he or she brings to the site, and he or she will be trained in taking decisions related to this specific stand-alone situation without having the casualty-ward team directly available.

Keywords
mobile training, medical first aid, emergency management

1 Introduction

In order to maintain the skills acquired during previous education, it is important to carry out training sessions, especially ones related to situations that might be unusual compared to the daily routine. This happens, for example, in critical situations experienced by operators who normally work in controlled environments, but occasionally and rarely, find themselves in the middle of an emergency.

The most efficient way of learning how to handle a critical situation and of maintaining the existing skills is by frequent management of real-life situations. The next best way to learn efficiently and to maintain that learning is by full-scale exercises, in which the technical and human resources are the same as in a real situation, but the role of victims is taken by stand-ins. However, real-life emergency situations are, fortunately, not frequent and full-scale exercises are extremely costly in terms of time, and human and financial resources.

Therefore, easier and more cost-efficient procedures for such training are needed; and a computerised training system for training medical staff for on-site emergency operations – partly funded by EUREKA (a network for market-oriented R&D) – has been developed by Risø National Laboratory and IFAD (providing software design and development expertise), and implemented and put on the market by IFAD. The training system has been developed for multi-user training (Andersen 2001); however, the system may also be used as a single-user mobile training system.

From a mobile learning point of view, two issues are highlighted: the ‘training anywhere and anytime’ aspect and the ‘mobility of people’ aspect. As regards the first, the system – installed on a laptop – may be seen as a mobile training set-up for individuals, to be used for training anywhere and anytime. In terms of the second issue, having the system installed in a network has solved the mobility problem. This allows the trainees either to be placed in the same training location in order to support the social aspects of the training session; or to be placed anywhere, geographically, in relation to the network and still address the team training aspects of the same scenario.

2 The training system

The realism of the system lies in a shared interactive scenario, in which actions taken by the acting participant will influence the scenario and be reflected in the presentation of the scenario, as in a real-life situation.

The training system must be adaptable to various situations in accordance with the actual type of emergency. When a medical trainee is faced, for example, with a minor emergency or a situation where only one medical doctor has arrived on the scene, he or she will have to give first medical care to the victims in the order in which he or she finds them or they are presented to him/her, and stabilise them until transport to a nearby hospital is available. As a multi-user training system, the system will – in addition – support the coordinated training also for the doctor in charge of the medical team, the doctors responsible for triage, and the group of doctors administering first aid.

3 The patient model

In the simulated world, the medical personnel must have some (pseudo)-realistic impressions of the synthetic casualty patient in order to react properly. He or she must be able to 'see' the patient, 'talk' with and 'listen' to him or her and be able to perform 'examinations'. At the same time, other types of information concerning events in the surrounding scenario must be presented to help or to distract the medical mind. The aim of the system is to teach the trainee how to work in unusual surroundings, identify patient reactions, make fast decisions, and send and receive informative signals to and from other levels in the system, all at the same time.

The casualty patient is presented to the trainee on the computer screen as a combination of text and a simplified figure (see **Figure 1** opposite).

If more than one casualty has arrived at the same time, it is possible to see them all in one view, but the figures are proportionally smaller. The drawing shows the visible signs and injuries; for example burns, bleeding, and pale skin. Only one side is *visible* at a time. The patient is fully dressed, but may be undressed if needed. Text explains the condition; for example, vomiting or shivering.

If the patient is conscious and able to talk, a 'spontaneous dialogue' mimics the communication with the medical person. Input from the scenario appears continuously. This is the platform for the medical reactions.

From menus on the screen, the trainee can ask the casualty patient about his/her condition and get answers (dialogue).

A wide range of medical examinations can be chosen from another menu. The resources (eg materials and skilled personnel) might be limited, and therefore make it impossible to perform the desired procedures.

The results of the different medical tests take time, and during the process, the system can do nothing else in order to mimic the constraints of the real world. When the result appears, it is shown on the screen for a few moments and then disappears. No curves or tendencies are shown. It is the trainee's job to keep track of the important information. Only parameters that are asked for are shown.

Medical treatment can be chosen from the menu. Time, available instruments and available personnel can be used in the treatment if necessary. The effects of the therapy are related to the patient model, and have an influence on the condition of the patient. Some types of treatment have a positive influence; others can be wrong or have no effect.

Other reactions – for example, orders to evacuate the casualty patient to the next level – can be selected from the menu. As in the other forms of menu work, the computer will not allow you to do something that is not possible in terms of the scenario (eg there might be a lack of ambulances).

The trainees themselves choose if they want to have an overall view of the environment – revealing the complete number of casualties – or if they want to approach a specific casualty for closer inspection. **Figure 1** (opposite) shows a graphical presentation of the latter, indicating a number of possible actions and highlighting specific features concerning measurements and observations. Likewise, **Figure 1** (opposite) indicates the human and technical resources available to the 'doctor'.

Examples of potential actions to be taken by the doctor are:

- communication with the casualties, making use of standardised questions, in case the casualty is able to communicate despite the injury
- possibility to zoom in on the casualty for better view of the damages
- possibility of undressing the casualty for better view of the damages
- turning the casualty for a complete inspection
- checking the colour and humidity of the skin
- measuring the pulse
- checking the eye reactions
- classifying the casualty for further treatment
- measuring the respiration by quality or frequency
- measuring of blood pressure
- checking the capillary response.

They may also carry out treatments such as:

- giving morphine
- attaching a drip
- putting on a bandage
- adding support
- stabilising the casualty for transport to a hospital selected according to expertise, capacity, and distance.

Figure 1
Layout of the presentation

4 Scenario execution

A number of scenarios are pre-planned, and may be chosen in order to start the session for the trainee. During the session, the trainee may experience the full sequence of events as in a real emergency situation. If so planned in the scenario, this goes from the very moment when the alarm goes off to organising the transport by car or ambulance. During the virtual tour on the way to the emergency site, the trainee may get further instructions about the emergency, and she or he may mentally prepare her/himself for the situation.

5 Results and evaluation

After the session, a detailed log can be produced of the medical reactions; for example, time spent on each patient, use of different types of resources, and the outcome for each patient.

The medical effects in the simulated system can be compared with the clinically widely accepted Abbreviated Injury Scale (AIS 1990) and the Injury Severity Score (ISS; Baker *et al.* 1974). Both techniques are based on an anatomical approach as in this simulation system.

Likewise, graphs may indicate the patient's likely development without any treatment and with the treatment performed, and both options can be assessed against the likelihood of a fatal outcome to the situation.

6 Conclusion

The system has been tried out by doctors in the nine somatic hospitals in Greater Copenhagen, partly replacing and partly ensuring better preparation for real on-site exercises. The outcome has been very promising, especially in terms of the increased number of trainees put through training sessions as compared with the 20–30 trainees per year, which were all that constraints of time and resources previously allowed.

References

AIS (1990). *The Abbreviated Injury Scale*. 1990 revision. Des Plaines, IL: Association for the Advancement of Automotive Medicine.

Andersen V (2001). Training of medical teams on-site for individual and co-ordinated response in emergency management. *International Journal of Emergency Management*, 1(1), 3–12.

Baker SP, O'Neill B, Haddon W and Long WB (1974). The Injury Severity Score: a method for describing patients with multiple injuries and evaluating emergency care. *Journal of Trauma*, 14, 187–196.

IFAD (2005). *Website*. At www.ifad.dk

Management of novel situations through mobile learning resources

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Abstract

The paper illustrates how systems developed in the past as platforms for emergency training and preparedness plans could, if redesigned for utilisation via the newly available mobile computing resources, offer more opportunities to deal with novel and unusual emergency situations.

A schematic view is also proposed as to how the roles and duties of the emergency organisations could change, and become more efficient to handle emergency situations.

Keywords
management of novel situations, emergency organisations, emergency coordination, mobile training

1 Introduction

Nowadays, emergency managers must handle situations that are often new, unusual and different from the traditional types of crisis for which they are trained. The increased complexity of countries' infrastructures and the excessive exploitation of environmental resources produces novel and emergent types of crisis.

Consider, for example, the wide range of improvised activities that would have been necessary after the catastrophic collapse of the World Trade Centre following the terrorist attack on 11 September 2001 (Kendra and Wachtendorf 2002). Nobody could have imagined such an anomalous and unexpected situation.

Apart from this terrible event, in the last few years, many regions have also been involved in many small crises caused by the loss of functionality of network information systems on which people and industries are dependent for everyday life.

Using the internet, we increase our connectivity with many other people around the world. On a positive note, the organisation of this conference today has probably been realised at a lower cost by exploiting the great connectivity capability available through the Web. The downside is that hackers and malicious people use the same e-mail channels to make their attacks worldwide, creating viruses that replicate themselves inside the mailboxes of e-mail users. These types of event and emergency are also novel and unexpected. Traditional techniques for detecting anomalies are unsatisfactory because they identify individual data points that are rare due to particular combinations of features.

In this context, *creativity* seems to be today an important element of successful disaster response. The literature of creativity is vast, spread among the arts, psychology, business and management, and philosophy. Clemen (1996) describes creativity as:

> *…new alternatives with elements that achieve fundamental objectives in ways previously unseen. Thus, a creative alternative has both elements of novelty and effectiveness, where effectiveness is thought of in terms of satisfying* [the] *objectives of a decision maker, a group of individuals, or even the diverse objectives held by different stakeholders in a negotiation.*

Given these factors, it becomes difficult to train emergency managers and other personnel to handle the new real emergencies using traditional methods such as the 'on-site' exercises that are normally practised in advance, or best practice manuals including norms and procedures designed for well-known types of crisis and disaster.

2 Management of emergency activity

The management of emergency activities is different from the management of activities, for example, inside a factory. In the emergency, novel situations and contingencies frequently arise that have to be handled by low-level personnel without the help and the support of higher-level managers.

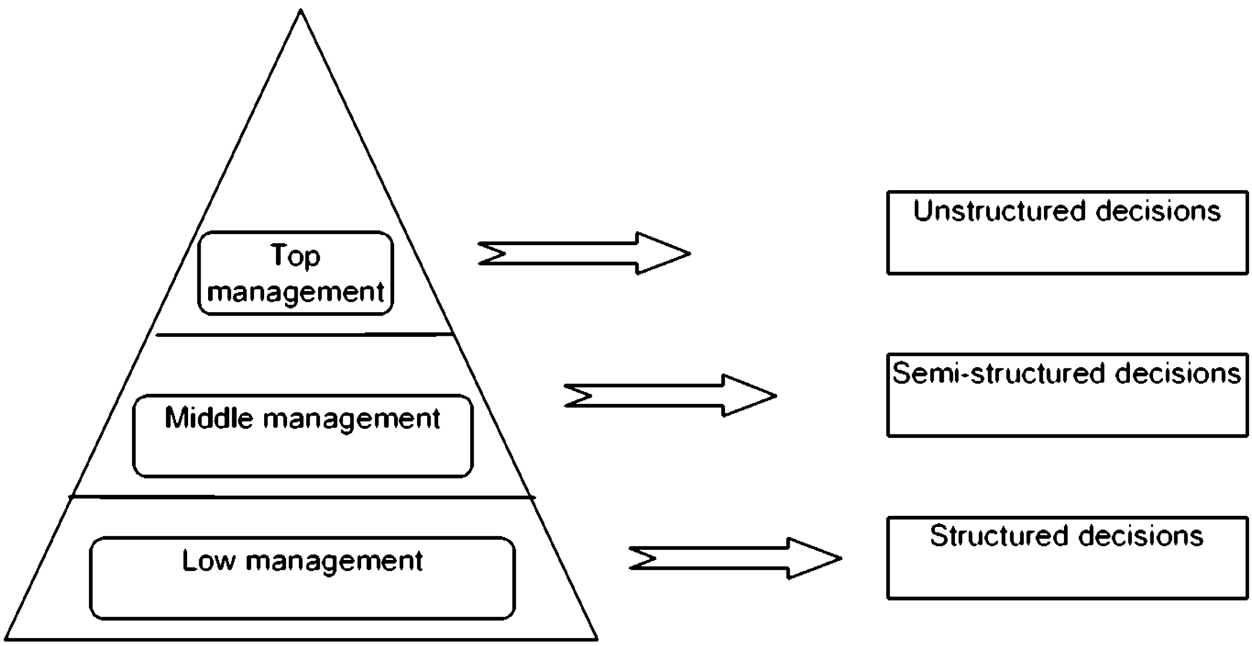
If we represent in a single schema all the managerial activities inside a factory, we have the picture in **Figure 1** – a pyramid, in which the strategic decisions are taken at the top; in the middle, we have some kind of directional control of the low-level activities; and at the bottom, the real operative activities are decided on.

The strategic activities are developed during a medium-length or long time period; the middle-management activities define the medium- or short-term objectives; and the operational activities realise these objectives in the real activity domain.

In such a type of framework, the operational activities of low-level management are realised by a certain set of rules or procedures whose selection is determined by control and strategic objectives defined at the higher level. In this way, the low-level personnel have only the responsibility for the execution of a certain decision and not for its control and selection.

During emergency management, the previous schema may no longer be applicable, especially when new and unexpected phenomena occur. In such cases, a predefined strategy to be applied during new contingencies may be not available, and the low-level emergency personnel have to choose a different strategy; due to time and geographical constraints, it may be difficult to ask middle and top management for a new strategy.

Figure 1 Schema of managerial activities inside a factory



3 Emergency training exercises

Training exercises, within a real or simulated emergency domain, could help the low-level emergency personnel to be prepared to handle the emergency situation. They could learn more about the availability of emergency resources, the possibility of resource sharing, the need for coordination with other operators, etc.

On-site exercises are carried out inside critical plants or infrastructures, by a simulation of the methods and resources planned for use in the case of emergency. All low- and high-level managers who participate in the exercises are asked to contribute to the simulation of the whole emergency scenario.

The main advantages of this type of exercise are to check the availability and working condition of all the needed resources, but the great disadvantage is that every person involved is normally advised beforehand, so that no type of novel situation can be introduced and lack of coordination is not verified. In addition, the cost of such exercises is very high and for this reason, they cannot be repeated more than once.

Emergency manuals, containing the norms and the procedures that must be applied during the crisis are often distributed to emergency organisations and also to the people that could be involved in a particular disaster due to the location of their home or to their type of work. The disadvantage here is that novel situations cannot be ruled out and this type of manual may be not available for a rapid consultation during the emergency itself, because people do not always take such manuals with them.

In the past, many systems have been developed to support a sort of 'virtual' training of emergency managers and operators (Balducelli, Bologna and Vicoli 1996). Computer platforms based on computerised emergency procedures, models simulating accidents involving fire, smoke and the release of toxic substances, and visualisations of emergencies using virtual reality have all been developed and tested.

Such types of system may give support not only during the training phases, but also during a real emergency, as, compared to a simple manual, they include simulation codes and virtual scenarios that can be configured using the parameters and the variables of an incoming emergency event. The problem is that normally during emergency contingencies, constraints on time would not allow the setting up and configuring of a system that is used rarely and for training purposes only. To be ready to use such systems during accident conditions, the emergency managers and operators would need to use it normally also during everyday work, but this may be impossible because they are normally static systems, not mobile.

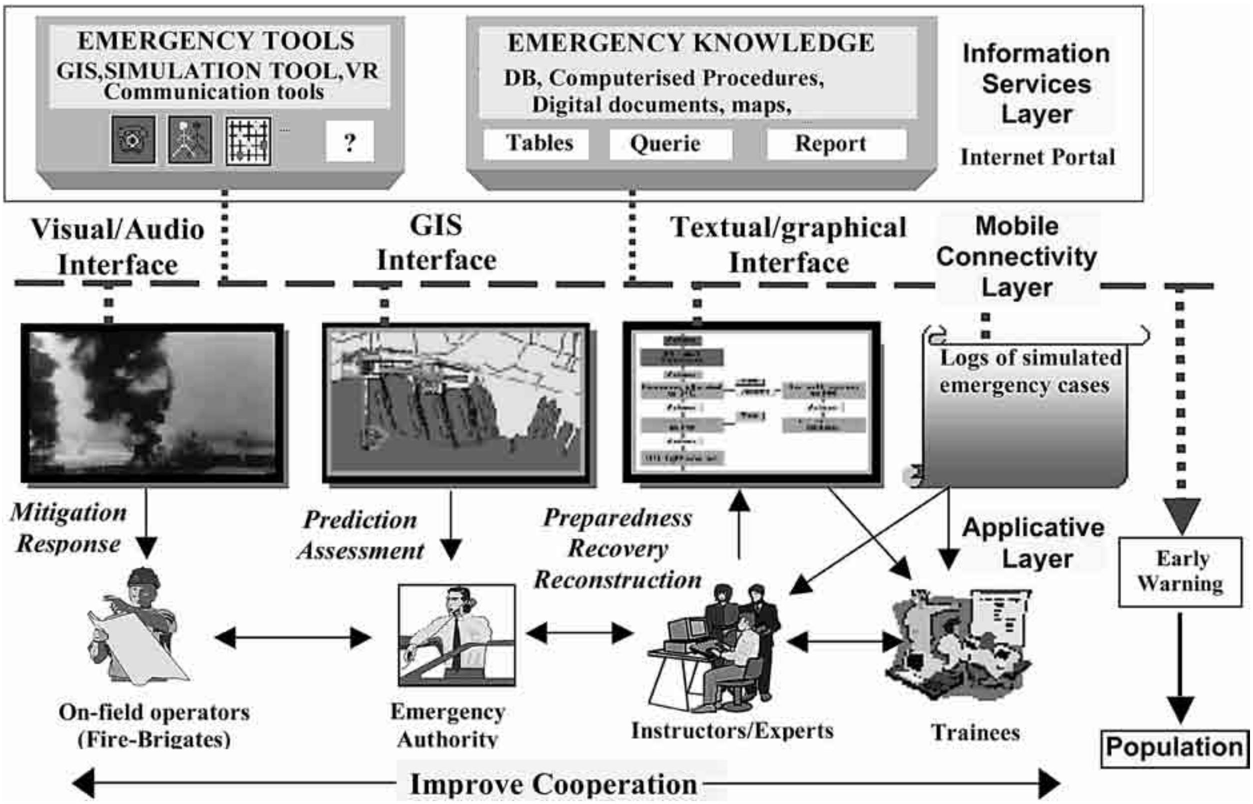
The recent availability, however, of 'mobile' techniques supporting all types of computerised device, such as portable computers and mobile phones has greatly increased the possibility of using emergency training systems more frequently. Compared to the first technologies, such as GSM (Global System for Mobile Communications), new technologies like GPRS (General Packet Radio System) based on TCP/IP have greatly increased the data transmission speed of mobile devices (from 9.6 Kbps to 124 Kbps). Many systems could be transformed from static to portable and it becomes possible to use them also during real emergency situations.

This new situation will be useful for emergency organisations that must be present on the ground at operative level.

4 Mobile emergency management containers

The new working methods to address emergency situations are supported by the increasing availability of *emergency knowledge containers* that can be queried and exploited during real operation. As pictured in **Figure 2** (overleaf), two main classes of container may be available: the tools container and the knowledge container.

Figure 2 Interconnectivity between emergency managers and emergency trainees



4.1 Tools containers

Many tools are useful during emergency management.

- A GIS (Geographic Information System) tool connected with a GPS (Global Positioning System) communication service is useful in order to have a 'real time' topological view of the territory involved in the emergency.
- Tools simulating the spread of fire or smoke, radiation levels, predicted traffic congestion, etc could also be useful resources running on top of the GIS system.
- Tools to communicate alarms or to check the number of people present inside the area involved may be also available: the majority of people today have a personal mobile phone that can be detected and contacted inside the emergency location.
- Tools including advanced algorithms able to analyse the incoming emergency data could be also developed and included inside tools containers.

4.2 Emergency knowledge containers

Several types of knowledge are useful during emergency management:

- databases containing useful data for making analysis and evaluations of the different types of accident scenario
- procedures to be applied by the emergency organisations during the crisis management and best practice norms that must be followed by the population during the emergency phases
- photographs, movies and every other type of digital document and map that can be useful in handling the emergency contingencies.

As pictured in **Figure 2**, the new mobile technologies permit a new type of mobile connectivity layer that allows for transportation of all relevant data and tools from the service information layer towards the applicative layer that is, in this case, represented by the on-site personnel, emergency authorities, instructors/experts and trainees.

4.3 On-site personnel

On-site personnel are generally emergency coordinators who must operate near the emergency location (eg the Fire Brigade). They have to ask off-site emergency authorities about the resources and the methods they think are (or will be) necessary to handle the emergency in the short or medium term. They decide on-site the best operative strategy to adopt in the management of the emergency resources.

Information and data collected by on-site personnel regarding the actual emergency state is very important and must be transmitted to emergency coordinating authorities.

It is obvious that for this type of personnel, radio transmitter–receiver devices needed to coordinate the work of other personnel involved in the emergency are very important. At the same time, they need a continuous connection link with the emergency authorities.

Radio transmitter devices are better than mobile phones as they use dedicated communication frequencies that are generally not congested even during an emergency. However, the disadvantage of these radio transmitters is that they do not permit communication exchanges between different public safety agencies: in fact, in many cases, they are based on incompatible technologies from different vendors.

Also, unlike mobile phones, they do not allow internet connection capacity which could be important in many cases.

In the last few years, new portable communication technologies have been developed with more standard communication protocols; for example, TETRA systems (Vilppunen 2003) which provide users with state-of-the-art features such as packet data applications, internet access, full duplex telephone interconnect and sophisticated end-to-end encryption. New-generation handsets will be ergonomically designed, compact, lightweight and have added functionalities such as built-in GPS, a Smart Text Editor and large ideographic displays that enable customised languages.

4.4 Emergency authorities

Emergency authorities are emergency coordinators that must manage/prevent the potential consequences that an emergency poses to the population at large, if emergency conditions have spread outside the location where it initially arose. In some cases, they must inform the general public using all types of available communication device. To carry out this task, it is very important for them to have the information coming from the personnel in the field regarding the emergency situation. For emergencies covering a wide area, they have to coordinate the sharing of resources between a number of personnel in the field. They have also, in some cases, to call the emergency experts who may be located far from the emergency location and quickly ask them the same questions.

In addition to communication devices, it is crucial for this type of emergency coordinator to make use also of computing devices furnished with emergency support systems.

4.5 Experts and instructors

The availability of the new mobile technology is analysed in an interesting work (Hansewinkel and Berggren 2003) where the authors discuss *a dual-use possibility – how consumer technology, bought for recreation and entertainment, could also be used as tools for experts working from home*. Many people today use entertainment and recreation technology at home, like wide-screen TV, surround sound and video integrated into a sort of home theatre concept; they have also internet connection, e-mail services, web digital camera and so on. A few years ago this technology was considered to be state of the art, reserved for governments, research centres and high-tech corporations.

Although this new technology is normally available at home, when it comes to vital social services such as the education of children in remote areas, long-term medical treatment, rehabilitation and telemedicine, it is more often used in public and semi-public buildings.

Hansewinkel and Berggren (2003) make the point that ‘surprisingly little effort has been made to use these technologies for society [social] services, in the context it has been developed for – the homes, by persons interested in this new technology, who often buy it anyway for their recreation’.

There is, in particular, one area where this technology has the potential to be used for vital social services: the potential for emergency experts to ‘work from home’.

This technology may be of special interest to emergency management experts who could participate in a virtual team to support society when it is under severe strain from emergency situations. There is the possibility of arranging web conferences, making this entertainment and recreation technology useful for the experts who must be involved during an emergency, especially if they reside a long way from the emergency location.

These technologies could also be useful for emergency instructors who could arrange courses for personnel in the field and emergency authorities.

4.6 Emergency trainees

Using these new technologies, the gap between the emergency simulation for training and the real emergency conditions will be reduced. The simulation of emergency training scenarios, created by the same entertainment and communication/computing technology that is used at home and in offices during the normal working day, will be more easily accepted by emergency managers, experts and authorities.

Computer-simulated training exercises that could also be carried out at home would be less costly and could be undertaken more frequently by the trainees. The exercises can be logged and executed more times in different locations for different types of trainee. Availability of more sophisticated mobile devices will allow us in the future to carry out part of these computer-based exercises at real emergency sites, so that the differences between on-site exercises and simulated ones will be reduced. This has positive implications for a more extensive use of emergency support systems and alarm systems which are able to reach people living near the site of an emergency. In fact, for an effective utilisation, the trainees need to be very familiar with what the support systems can do, and this type of knowledge can be acquired only by a frequent use of systems of this type.

5 Conclusions

The availability of new mobile computing technologies will in the future affect the roles, duties and powers of all emergency management personnel. The evolution of mobile technologies inside the emergency management organisations will proceed in the same way as it does inside other types of organisation or working group. One of the main difficulties will probably reside in the fact that knowledge and possession of the new mobile computing resources are unevenly divided between young and older people, but this is more a common generational problem that exists in every type of activity in our society.

References

Balducelli C, Bologna S and Vicoli G (1996). Evaluating the efficacy of virtual scenarios generation to support the training of emergency organisations. In *Proceedings of the 8th European Simulation Symposium: Simulation in Industry, 24–25 October*, Genoa. SCS, 108–112.

Clemen RT (1996). *Making hard decisions: an introduction to decision analysis*, 2nd edn. Pacific Grove: Duxbury Press.

Kendra J and Wachtendorf T (2002). Creativity in emergency response after the World Trade Centre attack. In *Proceedings of the 9th Annual Conference of the International Emergency Management Society, 14–17 May*, Waterloo, Ontario. TIEMS, 69–81.

Hansewinkel H and Berggren P (2003). Experts@home. In *Proceedings of the 10th Annual Conference of the International Emergency Management Society, 3–6 June, Sophia-Antipolis, France*. TIEMS, 315–325

Vilppunen H (2003). The communication preparedness of Finland for emergencies and disasters. In *Proceedings of the 10th Annual Conference of the International Emergency Management Society, 3–6 June, Sophia-Antipolis, France*. TIEMS, 419.

Logistics and medical support for isolated, mobile and disaster situations: the I–DISCARE concept

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Abstract

Telemedicine now has many applications in the field of hospital activities, but few have been realised in the context of isolated sites, or mobile or disaster situations, when the basic infrastructures are no longer available. This lack has now been addressed with the I–DISCARE system based on satellite technologies.

1 Background

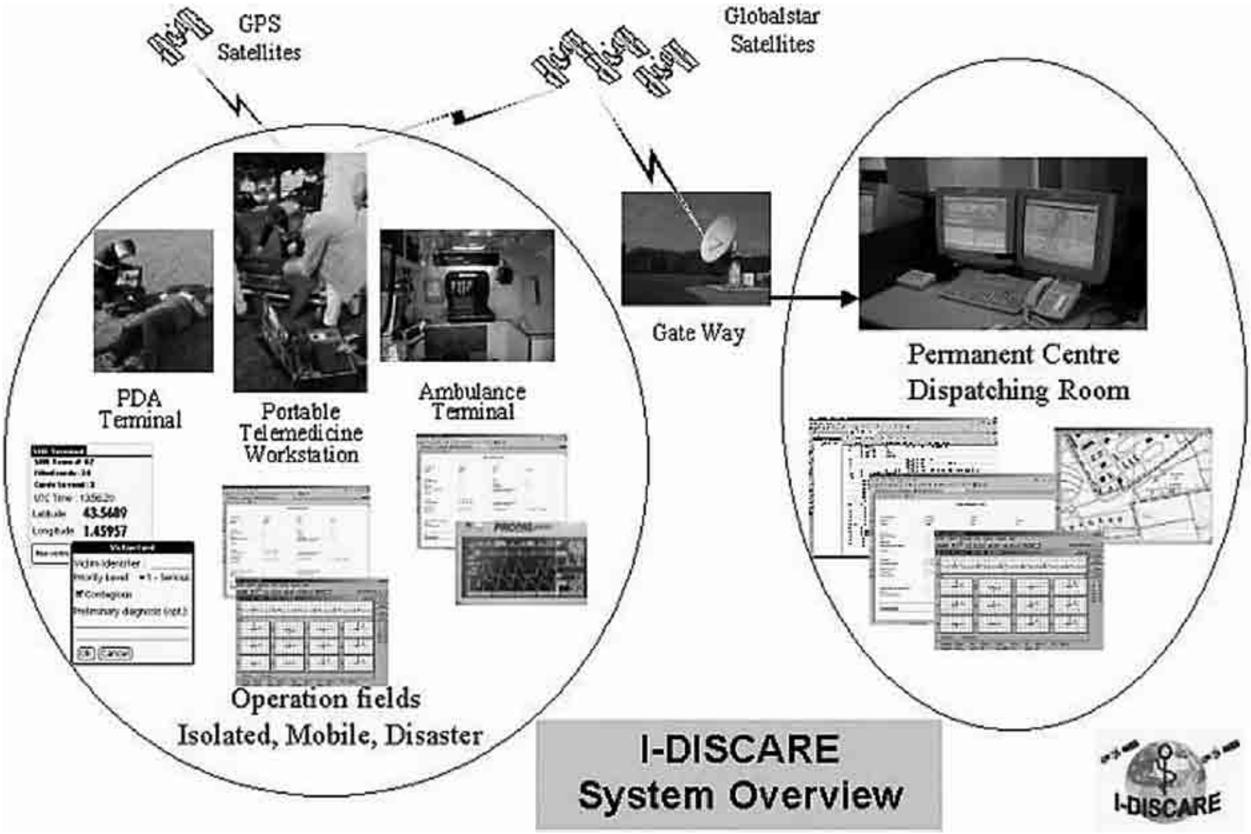
In 2001/02, thanks to grants from the European Space Agency's (ESA) ARTES 5 Programme, in the context of the DELTASS (Disaster Emergency Logistic Telemedicine Advanced Satellite System) project, engineers and medical doctors have succeeded in developing, integrating and demonstrating – via full-scale simulations – the utility of satellite systems and telemedicine in catastrophic situations. The industrial team of the project received recommendations from a 'medical group' involving European specialists in disaster and emergency medicine. After the DELTASS pilot phase, the I–DISCARE system is now entering its deployment and utilisation phase, which is funded by ESA.

2 I–DISCARE capabilities

In the context of emergencies like earthquake, flood, war or individual medical emergency cases, it is necessary to take the right and rapid decision concerning the triage and evacuation of casualties. For this to happen, the people responsible for this job need to have a clear view of the casualties' medical status and the activities of the teams operating in the field. The I–DISCARE system offers this clarity of vision at the three levels of the operation: search and rescue (SAR), evaluation of the casualty at the advanced meeting point (the place where the casualties are brought together before evacuation); evacuation of the casualty to the care centres. The I–DISCARE system allows personnel to follow (with timing and map localisation) the casualty hand-over, and a medical field card is generated both in a paper format and in parallel in a tele-transmitted digital format.

The general I–DISCARE system architecture (see **Figure 1** overleaf) demonstrates this capability.

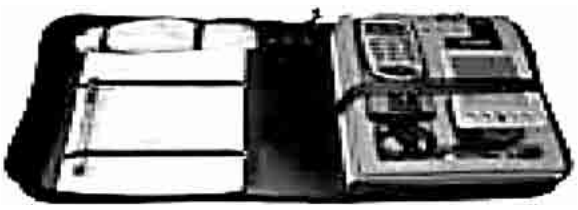
Figure 1 I–DISCARE system architecture



2.1 The PDA terminals

The PDA terminals (shown in **Figure 2**) equip the SAR teams and allow them to forward information to hospital personnel on the locale and identity of the casualty (via a predefined 5-letter code read on the paper medical field card), the level of gravity of their injury and a preliminary diagnosis. This equipment also permits phone communication between the different personnel via the Globalstar system.

Figure 2
The PDA terminal



2.2 The portable telemedicine workstations

The portable telemedicine workstations (see **Figure 3** opposite) equip the medical staff at the advanced meeting point and allow the transmission of objective medical data – 10-lead electrocardiogram (ECG), non-invasive blood pressure (NIBP), blood oxygen saturation (SaO_2), heart rate (HR), body temperature (T°) – and the locale of the casualty and medical staff [by Global Positioning System (GPS) service], always keeping this data attached to the unique casualty identification. The Globalstar satellite mobile phone can also be used for voice communication between the different personnel.

Figure 3
The portable telemedicine workstation

2.3 The ambulance terminal

The ambulance terminal (shown in **Figure 4**) equips the ambulance that ensures the evacuation of casualties to care centres. It permits the transmission of objective medical data – 3-lead ECG, NIBP, SaO_2, HR, T° – and information on the locale of the ambulance, always keeping this data attached to the unique casualty identification. Again, the Globalstar satellite mobile phone can also be used for voice communication between the different personnel.

Figure 4
The ambulance terminal

2.4 Coordinating operational centre

At the level of the coordinating operational centre (which can be a permanent centre or a temporary deployed centre), all the data coming from the SAR team, the team at the advanced meeting point and the ambulance teams can be displayed. At each tele-transmission, the position of the team is attached, which allows a mapping of the different personnel in the field.

The operational management team has a permanent view of the rescue and the ongoing evacuation operations; information on the number of victims with their medical status is accessible. The traceability and history of the rescue operations is automatically provided. The management of the rescue operation becomes easier thanks to the I–DISCARE system.

3 Who are the potential I–DISCARE users?

The complete I–DISCARE system should interest the medical emergency organisations working in disaster situations, like the Fire Brigade, civilian protection organisations, humanitarian organisations and military institutions. Some subsystem of I–DISCARE can be used in other situations, as follows.

- The PDA terminals are well adapted for search and rescue operations by mountain emergency organisations.
- The portable telemedicine workstations are well adapted for medical emergency situations on board long-haul flights; in a maritime context on board boats; for off-shore platforms; for remote workplaces; for expedition/traveller assistance in isolated areas; for sanitary stations in remote areas; for doctors working as general practitioners (GPs) in remote regions.
- The ambulance terminals are well adapted for ambulance companies working in remote areas.

4 Conclusions

The DELTASS project has made available a complete system that will now be deployed within the users' community via the I–DISCARE pilot operations. The proposed system is sizeable and adaptable to users' specific requirements.

The I_DISCARE project will be piloted on a free basis, offering the following options:

- adaptation of the man–machine interface software of the terminals and consoles to satisfy the user's criteria: (language to be used, format and content of the field medical cards, necessary maps)
- a loan of the chosen equipment for a period of 2–4 months to try it out: equipment includes: three PDA terminal(s), one portable telemedicine workstation(s), one ambulance terminal(s), and if necessary, one server and one console on the user's premises
- training for personnel in how to use it
- installation of the system on their premises and in ambulances. We ensure the repair and maintenance of the equipment during the period of the loan.

The following will be proposed to customers on a commercial basis:

- *either* periodical or temporary leasing of equipment to customers (including satellite telecommunication services subscription, the communications cost being covered by the customer) with a purchase option. The I–DISCARE system will be made available and deployed in the customer premises within 48 hours in the European area.
- *or* a simple purchase of the equipment with satellite telecommunication services subscription.

For both options, the following services will be included:

- installation and configuration of the system
- annual maintenance and upgrading of the system
- regular user training.

Further information

For further information on the project and the organisations involved, please visit the following websites.

Elsacom: www.elsacom.com

Globalstar: www.globalstar.com

MEDES: www.medes.fr/idiscare

NST: www2.telemed.no/english/nct/index.html

http://telecom.esa.int/telecom/www/object/index.cf m?fobjectid=750

http://telecom.esa.int/telecom/www/object/index.cf m?fobjectid=7564

www.esa.int/export/esaCP/ESACZSTHN6D_Benefits_0.html

www.esa.int/export/esaMI/Telemedicine_Alliance/ESAPX27708D_0.html

Author index

The third annual international mobile learning conference MLEARN 2004 was organised by the MOBIlearn and m-learning projects. The main purpose of the conference was to bring together people interested in developing opportunities, systems and content for learning with mobile and wireless devices and networks as well as researchers and educationalists with an interest in mobile learning. Speakers and delegates included education and training practitioners, designers of mobile learning materials and services, hardware and software technology developers and researchers from mobile learning projects around the world. The interesting and varied papers in this edited book are based on presentations given at MLEARN 2004 and they provide a flavour of current achievements and work-in-progress in the field of mobile learning.

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