AN INTRODUCTION TO MOBILE LEARNING

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FOREWORD

This book *An introduction to mobile learning* is a product of the Socrates project ‘The role of mobile learning in European education’.

The project partners were:

- Ericsson Education Ireland
- TecMinho, Guimarães, Portugal
- University of Plovdiv, Bulgaria
- Corvinno Technology Transfer Centre, Budapest, Hungary
- NKI, Bekkestua, Norway
- The European Consortium for the Learning Organisation, Wavre, Belgium.

The book is in four parts.

Part 1 is an international study of the achievements of mobile learning today.

Part 2 is a study of the achievements of mobile learning today in all the countries of the European Union.

Part 3 is a study of the pedagogical aspects of mobile learning and how these differ from face-to-face education, distance education and e-learning.

Part 4 is a programme for the role of mobile learning in European education today.
INTRODUCTION

The project ‘The role of mobile learning in European education’ has completed two major studies of mobile learning.

The first study is an international analysis of the achievements of mobile learning worldwide. It is 180 pages in length and deals with Australia, Canada, India, Japan, Republic of Korea, south Africa, Taiwan and the United States of America.

Much of the data is unique, little known and not available elsewhere. Extensive bibliographies are included of mobile learning in Japan, Korea, Taiwan and China which will be of value to other researchers in the field.

The study shows that Japan, Taiwan and South Africa are world leaders in the field of mobile learning and that both Korea and China have great potential to also become major players. Considerable activity has also been documented in Australia, Canada, India and the United States of America.

The full text of the report is available on the project website Http://www.ericsson.com/socrates2006.

The goals of the study are:

- To show that mobile learning is developing rapidly in many parts of the world
- To bring to a wider audience the little-known achievements in mobile learning of a range of countries
- To convince the European Commission and the 27 European Union Ministries of Education that mobile learning is a vibrant field which should be supported
- To emphasise that European leadership in wireless technologies needs to be extended to mobile learning as well.

The second study is an analysis of the achievements of mobile learning in 28 European countries today (the 27 members of the European Union and Norway). It is 300 pages in length. Again much of the data is unique, little known and not available elsewhere.

The results of the data collected allow one to rank the European countries in 4 levels with respect to their achievements in mobile learning.

At level 1, there can be no doubt that the United Kingdom is the leading provider. The United Kingdom has at least 4 areas of provision: primary and secondary schools, universities, government departments and corporate providers.

Provision at primary and secondary school level is vibrant. This work began with Professor Mike Sharples, then of the University of Birmingham, working
with primary school children who recorded and analysed data on PDAs. Hundreds of UK primary and secondary schools attended the Handheld Learning Conference in London in October 2007, and this gave the conference a noticeable school-level focus.

Many UK universities are active in the field. Leaders are the University of Nottingham (Prof Sharples), the Open University which has a mobile learning research group that produced the major book in the field, London Metropolitan University, which has produced extensive mobile learning courseware and the University of Bristol (Dr Wishart) which has produced extensive mobile learning materials for teacher training.

The government agency LSDA led a major EU project to produce literacy and numeracy mobile learning materials for disaffected youths and its successor LSN is again involved in a major project, MoLeNET. BECTA has also worked extensively in mobile learning.

There are a wide range of British companies involved either in the production of mobile learning systems or of mobile learning courseware to run on these systems. These include Tribal CTAD, Handheld Learning, ConnectED, Learning in Hand.

1000 British delegates are expected at the Handheld Learning conference to be held in London in October 2008. If each of these delegates has been involved in the provision of mobile learning in some way, then mobile learning in the UK is thriving indeed.

Level 2 consists of countries in which there has been mobile learning activity mainly in the form of participation in European Commission funded projects. These countries are: Austria, Bulgaria (notably the University of Plovdiv), Cyprus, Czech Republic, Denmark, Finland, Hungary (notably Corvinus University of Budapest), Ireland (notably Ericsson Education Ireland), Italy (many university and government research centre projects), Netherlands, Norway (notably NKI), Portugal, Slovakia, Slovenia, Spain, Sweden.

Level 3 countries are making their first fragile steps in the field of mobile learning. These countries are: Estonia, France, Greece, Latvia, Lithuania, Malta and Poland.

Level 4 countries are those in which little or no activity in mobile learning has been documented. These countries are Belgium, Luxembourg and Romania.
The data collected by the project show that Japan, Taiwan and South Africa are world leaders in mobile learning.

**JAPAN**

The study on Japan, like all the other national research studies carried out by the project, starts with political, demographical and telecommunications data on Japan.

The research on mobile learning in Japan was carried out as desk research. It was possible to get in contact with key researchers in Japan who submitted information and papers in electronic formats.

Japanese researchers use the concepts pervasive learning and ubiquitous learning, rather than mobile learning, to emphasise that mobile devices often are applied in learning situations taking place at a place directly related to the object of learning. Often, mobile learning is organised as collaborative learning focusing on sharing knowledge and social knowledge building.

There is high government attention to develop Japan into an ubiquitous learning society where mobile devices are widely used for increasing welfare and life-long learning for all. There are some universities specifically working on the development of solutions for mobile learning: Tokushima University, University of Tokyo, Oita University and Kobe University.

Surveying the situation concerning mobile learning in Japan was a difficult endeavour, as much of the literature and information on Japanese web sites is in Japanese and thus not easily available for a researcher who does not understand Japanese. The study is 38 pages in length and has 53 references to Japanese studies of mobile learning in English.

**E-LEARNING IN JAPAN**

Mobile learning is seen in the context of e-learning. According to Kubota & Fujikawa (2007) Japan lags behind many other nations in the use of web based technologies. If correctly observed, this is surprising as Japan at the same time is one of the world’s most advance developers and users of information technologies, and these technologies are employed in all sectors of the Japanese economy including the academic sector. Kubota & Fujikawa (ibid.) assume from general reports on the use of the Internet that e-learning is not well developed in Japan. It is also suggested that Japanese people are culturally not very attracted to distance learning. Kubota & Fujikawa (ibid.)
claim that this fact (or problem) is addressed by the project called “e-Japan” initiated in 2001 with one of the objectives of developing web based IT education or “e-learning”, including the development of human resources necessary to support this endeavour.

**SOME DEFINITIONS**

**Mobile learning**

As mentioned, it seems that the Japanese researchers often prefer to use the terms research on pervasive learning or ubiquitous learning environments instead of the concept m-learning or mobile learning.

Sariola et al. (2001) discuss the concept, m-learning, from the perspective of educational theory. A technology-based definition is obviously not sufficient, and they also try to include aspects of technology. They introduce the characteristics, ‘portability’, i.e. the equipment is so light that we can carry the devices that we call mobile, ‘wireless’; there are no wires in the equipment, and ‘mobility’, we are moving when using the technology.

They claim that it is the mobility that is most interesting from an educational viewpoint. Concerning mobility, they raise the question about ‘who’ is moving, ‘why’ and ‘where’. If moving is not related to the learning activity as such, why a person is moving might be irrelevant from an educational viewpoint. However, it is the challenge of the educational institution to satisfy learning needs for people on the move (and we could add to support teachers who move to continue their tasks concerning student support). Sariola et al. (ibid.) note that conducting educational activities while moving, might deal with *convenience*, e.g. rational time management or *expediency*, e.g. the person is moving to a place relevant to the subject studied.

**Pervasive learning**

The term pervasive learning seems sometimes to be used nearly synonymously with the term ubiquitous learning. E.g. Thomas (2007) defines pervasive learning and ubiquitous learning as the same phenomenon:

“Pervasive—or ubiquitous or ambient—learning relies on the concept of “always on” education. Always on education is available 24 hours a day, 7 days a week, anywhere, at anytime. Pervasive learning is a social process that connects learners to communities of devices, people, and situations so that learners can construct relevant and meaningful learning experiences, that they author themselves, in locations and at times that they find meaningful and relevant. This definition points to four key elements of pervasive learning and it is these elements that comprise the four key components of the pervasive learning model: Community, Autonomy, Locationality, Relationality

**Ubiquitous learning**
The concept ubiquitous learning is defined on the web site of the project of the same name at University of Tokushima, CLUE – Research on Ubiquitous CSCL (Computer Supported Collaborative Learning). (CLUE stands for Collaborative-Learning support-system in Ubiquitous Computing Environment.) These are claimed to be the main characteristics of ubiquitous learning: Permanency, Accessibility, Immediacy, Interactivity, Situating of instructional activities, Adaptability.

The paper by Ogata and Yano (2004) discusses the concepts of computer assisted learning, mobile learning, pervasive learning and ubiquitous learning. They argue that the fundamental difference between mobile learning and desktop computer assisted learning is that mobile learning fundamentally is about increasing the possibility of the learner to move and take their learning environment with them. The evolution of different mobile learning solutions has been accelerated by a number of technological advances such as improved wireless telecommunication capabilities, open networks, increase in computing capacity of handheld devices, emergence of more flexible software solutions, and not least improved battery capacity.

Pervasive learning involves in addition to mobility that the learning device can obtain information about the context from the learning environment or that models of specific learning environments are built into the learning device. According to Ogata & Yano (ibid.) ubiquitous learning integrates high mobility with pervasive learning environments. They note, however, that a broad definition of ubiquitous learning includes both mobile learning and pervasive learning. They present the following model of learning environments based on Lyytinen, K. and Yoo, Y. (2002):  

![Figure 1. Comparison of learning environments (Lyytinen, K. and Yoo, Y. (2002) after OGATA & YANO (2004).](image)

i-mode (1999)

NTT DoCoMo’s “i-mode” Internet Service was launched in 1999 and had in June 2006 close to 50 million subscribers. The i-mode service is a service that intends to make the mobile phone a useful tool for everyday life and includes
services for learning and also services for learning content developers ([http://www.nttdocomo.co.jp/english/service/imode/about/index.html](http://www.nttdocomo.co.jp/english/service/imode/about/index.html))

A few months after the launch of i-mode DoCoMO’s competitors, KDDI and J-Phone launched similar services. These three major mobile data services had over 80 million subscribers in June 2006. i-mode and the other data services have become a success because of well-designed services and business model, and also the strong demand for mobile e-mail services (Wikipedia 2007).

According to Vincent (2001) i-mode became an undeniable success based on its construction on the top of a packet-based mobile network. Both voice calls and a number of other functionalities were available through the screen, keypad and navigation buttons. The business model makes it possible for learning providers to get paid for content and learning services.

Possibilities and experiences are discussed by Goto (2006) who notes that because i-mode’s Java environment is open to a wide public, it gives vast possibilities for educators to become content providers for mobile phone users. Goto (ibid.) describes the experience from a study at Tsukuba University on developing and trying out exercises based on Java applications in increasing general knowledge in subjects such as Japanese, English, mathematics, etc. High-school and college students could individually utilize the exercises anytime anywhere, for their preparation of the employment examination and so on. The study was evaluated both by measures of learning results and by a web questionnaire. According to Goto (ibid.) there are works underway to deliver exercises on a large scale for mobile phone users.

**Ubiquitous Japan (U-Japan) (2001)**

The determination of national IT strategies in Japan was initiated with the “e-Japan Strategy” in 2001. The main focus was to promote broadband capabilities to the Japanese population. The strategy was reviewed in 2003, where the concept of ubiquitous networks became a central focus. The new “U-Japan Strategy”, where the main aim is to promote a unified and consistent approach to ubiquitous networking, includes constructing a new ubiquitous network structure, establishing an infrastructure for usage and promoting the use of the ubiquitous network.

The developments to take place within the U-Japan Strategy are based on four principles: ubiquitous (connects everyone and everything), universally adapted (can be used of everyone, elderly, handicapped etc.), user-oriented (based on users’ needs and viewpoints), and unique (creative and vigorous). Of these principles, ubiquitous is the most important – the network shall be characterized by the realization of easy ‘person-to-person’, ‘person-to-goods’ and ‘goods-to-person’ communications and easy connection to networks ‘anytime, anywhere, by anything and anyone’ by attaching small low-priced devices to all kinds of things in all kinds of places (Ibid. Section1, Chapter1).
Although learning is not on the top of the list, one should notice that approximately 20 percent of the respondents see “lifelong learning” as very important. It is not difficult to see the relationship between Japan’s emphasis on developing the ubiquitous networks and the research on mobile learning, pervasive learning and ubiquitous learning.

PROJECTS


The project is conducted by Hiroaki Ogata. CLUE stands for ‘Collaborative-Learning support system in Ubiquitous computing Environment’. As far as we understand; CLUE is an ongoing project covering a number of subprojects and following some previous projects on pervasive and ubiquitous learning using PDAs. CLUE is a prototype system which consists of a server and clients. Each learner’s client of CLUE is Toshiba Genio-e that is a PDA (Personal Digital Assistant) with Pocket PC 2002, Personal Java, GPS (Global Positioning System), and wireless LAN (IEEE 802.11b). This specific device was selected to be able to use GPS and wireless LAN at the same time. The server program has been implemented with a java servlet via Tomcat.

TANGO (Tag Added learner Objects) (2004)

The learning environment, TANGO, detects the actual objects around the learner using RFID (Radio Frequency Identification) tags, and provides the learner the right information for language learning. This system supports learning in daily life with a PDA (personal digital assistant) beyond web based education with desk-top computers. The system is tried out in connection with Japanese beginners’ learning of English. The idea is that RFID tags are attached to real objects. The tags bridge authentic objects and their information in the virtual world. The TANGO system detects the objects with RFID tags around the learner and provides the learner with the right information in that context.


The project is generally on learning the skills of language use, reading, writing, listening and speaking. It is a main aim to learn expressions specifically for the daily life of the learner. However, it is also important to have some cultural knowledge to be able to use the language according to non-written rules in the cultural context. In Japanese it is important to adapt expressions related to the actual situation. Proper use of polite expressions is dependent on the situation and context.

BSUL – Supporting Classroom Activities with the BSUL environment (2005)
This research project concerns the integration of ubiquitous computing into classroom settings. The aim is to give basic support to classroom and field learning activities. In the classroom the students interact with each other and the teacher through an Internet enabled PDA. CSUL (Computer Supported Ubiquitous Learning) means supporting the teaching and learning process using embedded and invisible computers in everyday life. The system gives access to different information networks at the time the information is required by the learner.

The BSUL (Basic Support for Ubiquitous Learning) environment aims to support learning inside and outside the classroom.

**LOCH: Supporting Informal Language Learning Outside the Classroom with Handhelds (2005)**

LOCH is a computer supported ubiquitous learning environment supporting language learning in a physical space where the learning takes place. The teacher designs field learning activities to take place when the students move around a city to carry out and share learning experiences with other students. The main aim of the project is to integrate the knowledge acquired in the classroom and the real needs of the students in their daily life using PDAs.

![Figure 9. PDA, GPS-module and PHS technology in the LOCH Project (Paredes et al. (2005, p. 184)).](image)

**JAMIOLAS ((Japanese Mimicry and Onomatopoeia Learning Assisting System) (2006)**

The Japanese language is especially rich in mimicry (words imitating situations and body movements) and onomatopoeia (words imitating sounds) (MIO words). The JAMIOLAS project developed the system for learning MIO words, of which there are around 2000 in Japanese. As the usage of MIO words depends on the situation of the speaker, JAMIOLAS, a context-aware
language-learning support system, was developed to support learning MIO words using sensors, which detect the speaker's situation.

**LORAMS (Link of RFID and Movies System) (2007)**

LORAMS supports the learners with a system to share and reuse learning experience by linking movies and environmental objects. These movies are not only kind of classes’ experiments but also daily experiences movies. These movies can be shared with other people. LORAMS can infer some contexts from objects around the learner, and search for shared movies that match with the contexts. These movies are thought to be useful to learn various kinds of subjects.

Chris Houser and Patricia Thornton at the Department of Information Culture and the Department of Language and Culture have carried out and published some important works on mobile learning with reference to Japan (see [http://studypatch.net/mobile/#LOTM](http://studypatch.net/mobile/#LOTM)) (Houser et al. 2002)

The researchers surveyed 333 Japanese university students regarding their use of mobile devices. 100% reported owning a mobile phone. 99% used their phones to send e-mails, exchanging some 200 email messages each week. 66% sent e-mails to peers about classes; 44% sent e-mail for studying. This is in contrast with only 43% email on PCs, exchanging an average of only 2 messages per week. Only 20% had used a PDA (Ibid.).

According to the information received from Makiko Tagenaka at the *Center for Research in Education and Human Development, Kobe University*, there has been collaboration between this centre and researchers at *Faculty of Human Development, Kobe University* and also an elementary school affiliated with Kobe University on different uses of mobile phones to stimulate collaborative learning among school children.

**Collaborative Learning using Camera Equipped Mobile Phones (2004)**

This project tested out among first grade elementary school children a learning support system using camera-equipped mobile phones (Takenaka et al. 2004).

**A Study Support System Based on Mobile Phones and Web Based Information Sharing (2005)**

The aim of this study was to examine the effectiveness of a system supporting children in reporting activities to be conducted at home. The same system as described above was used also among first grade elementary school pupils. The subject was a unit in ‘Life environment’ and concerned the roles of family members and aimed at making the children take part in housework. Also here the pupils took pictures with the mobile phones and sent them as e-mail attachments to a web-site for easy sharing of texts and images. The experiment showed that the children enthusiastically worked on the reporting activities using mobile phones, and also that they were able to find interests in
the contents of their activities. It was also assumed that the parents generally approved the educational use of mobile phones (Takenaka et al. 2005).

The Use of Mobile Phones in Mutual Monitoring (2006)

This project was carried out among second grade pupils. In addition to sharing of information this experiment tried out the use of mobile phones for supporting mutual monitoring of the pupils’ field work. The system enabled the users to access via the mobile phone the latest information input by other users in a distributed learning environment. Information on activities in progress was displayed graphically on the mobile phone screen. The system was evaluated on the basis of the pupils’ judgement of whether they enjoyed using the system and its operability and a behavioural analysis of the pupils’ activity when using the system. According to the researchers the trial indicated that the mobile phone aided support system was proved to be useful (Takenaka et al. 2006).

ProBoPortable: Cellular Phone Software to Promote Emergent Division of Labor in Project-based Learning (2007)

This project has designed, developed and tried out a cellular phone application for ‘project based learning’ (PBL) (see Mochizuki et al. (2007)). The research is a result of collaboration between a number of universities, research institutes and a private corporation.


This project tries to solve some of the problems concerned with educational assessment. It is argued that most conventional assessment is not fully valid in reflecting the learner’s ability to perform in real situations. Similar to situated learning, situated assessment differs from educational assessment in schools in that it takes place in the course of social interactions as part of the group’s cultural practices. The aim of the research on using handheld devices for mutual situated assessment is to make students carry out mutual assessment without bothering other participants or disturb collaboration and also make participants aware of others’ evaluation. The system designed uses PDAs that can be used easily in a learning group without disturbing the ongoing activity and provide feedback on others’ assessment. The system is named ‘Sounding board’. All learners have a PDA with defined push buttons and directional IR receiver with wireless access to a database. The learners also have an Identification badge with IR sender. To assess others with this system, a user has to point the terminal toward a target person and push a button. The input action is supposed to be so easy that it scarcely disturbs the ongoing activity. The action of pointing the terminal toward the target is assumed to produce a natural awareness in the participants concerning the assessor and the one who is assessed. The content of the assessment can be notified by an audible announcement that accompanies the pushing of a button. In this way, the users can be aware of their mutual assessments (Kato et al. 2006).
A Response Analyzer System using Mobile Phones (2005)

This research has been carried out at Waseda University by Nagaoka (2005). The background for research is described as both the penetration of mobile phones and mobile phone functionality, and also the higher education reform including transfer of credits and a pressing issue of improving methods including acceptance of distance education. The system described by Nagaoka (ibid.) was piloted in a face-to-face university class (on the subject distance education) including a simulated distance education setting.

CONCLUSIONS

This survey of mobile learning and research on mobile learning in Japan has shown that Japan in many respects is in the forefront of applications of mobile devices in education. Thanks to information from a number of Japanese researchers in the field we have managed to identify a number of research and development projects on mobile learning in Japan. On the other hand, we feel that there is no doubt that there probably are more examples of applications of mobile devices in education in Japan that we have not been able to discover – partly because much information is published in Japanese only.

From the general overview of Japanese education it seems that in spite of being one of the most technologically advanced countries in the world, it seems that open and distance learning is less developed than in many countries in the western world. Thus, the use of mobile learning as part of distance education and a means to make distance education more flexible and more accessible to learners on the move is not typical for the development of mobile learning in Japan.

Although much research on the use of handheld devices to increase the quality and effectiveness of learning seems to originate from technological research environments, the research is clearly based in educational theory, to a large extent on collaborative and situated learning theories.

Most of the research discussed above concerns the use of mobile telephones, PDAs and specifically developed technologies in ordinary primary education or in university and college teaching. Many projects use mobile devices in an attempt to increase the individualization of learning by adapting learning content and activities to individual needs and/or to stimulate interaction and collaboration between learners. Some projects experiments specifically with mobile devices to stimulate learning taking place in real situations when the students are moving around to experience real life situations as part of the learning process.

Language learning is important both for Japanese students learning mainly English and for foreign students learning Japanese. Language learning is an important application for mobile learning both on mobile phones and PDAs in Japan.
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**TAIWAN**

The study on Taiwan, like all the other national research studies carried out by the project, starts with political, demographical and telecommunications data on Taiwan.

Taiwan is a small island, but very strong when it comes to mobile learning.

The country already has a very good mobile telecommunication infrastructure, which is under continuous development due to the strong commitment of the government. The latest technology finds its way into education as well.
Schools, universities are picking up mobile educational services based on the highly developed telecommunication infrastructure.

Not only the usage of these services is remarkable in Taiwan, but also the amount of research activities, carried out by various universities and research organisations.

**MOBILE TECHNOLOGY**

With its strong focus on the role of technology, and telecommunications in particular, throughout its economy, it is not surprising that Taiwan has one of the most advanced telecommunications networks in Asia. With excellent telecommunications infrastructure in place and the innovative use of breakthrough information technologies, the country continues to be well placed to drive both mobile and data communications services.

There has been a real and continuing boom in telecommunications development. Annual telecommunications service revenues were running at around US$12.5 billion in 2006 and of that around US$7.25 billion was coming from the mobile sector. There is also a hefty ongoing investment in telecoms infrastructure.

Coming into 2007, fixed-line telephone penetration was around 60% and mobile penetration was a little more than 100%. The mobile figure has fallen back from a peak of more than 111% in 2003. In recent years, the highly penetrated mobile market has been experiencing some volatility as the market sorted itself out. The mobile sector was given fresh direction in 2005 with the launch of 3G services by the three major operators. The next generation of mobile services has certainly been presenting a healthy challenge to the market. In fact, the 3G subscriber base has been expanding at an annual rate of around 100%; by end-2006 3G services already comprised 8.5% of the total mobile market. The other important element in the launch of 3G is that it has given a boost to operator revenues. By December 2006, the overall Average Revenue per User (ARPU) for 3G in Taiwan was running at about 30% higher than for 2G.

The broadband market in Taiwan is also one of the more heavily penetrated in the world. With around 90% of households having some form of Internet access, almost 60% of all households have some form of high-speed broadband access to the Internet. DSL provides the dominant platform for the broadband access. Taiwan’s Broadband subscriber base was growing at an annual rate of about 10% coming into 2007.

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**Mobile Learning and Pervasive Computing – Local definitions**

*What is mobile learning?*
The field of learning through technology is a vast one with subtle distinctions among its various branches. Distance learning incorporates all forms of instruction in which instructor and student are physically removed from one another by time or space from traditional correspondence courses to web-based instruction. Electronic or eLearning incorporates all forms of online instruction using personal computers.

Mobile learning, sometimes called m-learning, is learning accomplished with the use of small, portable computing devices. These computing devices may include: smartphones, personal digital assistants (PDAs) and similar handheld devices. There is some debate on the inclusion of tablet and laptop computers. Often, wireless two-way internet connection is assumed as an integral component.

What is pervasive computing?

Pervasive computing occurs when the entire environment becomes embedded with information accessed through devices that will range from desktop computers to handheld devices to items in development such as wearable computing devices.

In terms of eLearning laws and regulations, the development of eLearning in Taiwan is slower than other countries. The Government thinks that it is a critical time to establish a well-rounded eLearning environment.

Mobile Learning in general is considered as a subset of the national eLearning strategies and systems.

**eLearning guidance**

The Ministry provides guidance of educational policy and personnel training in Taiwan, related to the following items:

- Standard Operating Procedure of the instructional design in eLearning
- Research on academic fair use and to establish the mechanism of permission to quote agreements
- Demonstration, implementation, and promotion of mobile learning
- Research on the security requirements and standards of schoolbag, reasonable user-end environment, and physiological and psychological effects

**M-Taiwan: A National Program to Realize Taiwan WiMAX Blueprint (2005)**

M-Taiwan, an extensive mobile Internet application and services infrastructure development project, is designed to ensure that high-speed, wireless broadband access is available almost everywhere on Taiwan. In an attempt to promote the development of Taiwan’s communications industry, M-Taiwan focuses on the three main areas of M-Service, M-Life, and M-Learning with
the goal of establishing wireless broadband M-Cities and providing wireless access services to eight million subscribers. Through the widespread adoption of wireless applications, M-Taiwan aims to improve Taiwan’s international ranking for mobile Internet access and the international competitiveness of its cities. It also intends to go one step further to reach its goal of helping Taiwan export not only products, but also total system solutions to the world.

![Figure 5. Road to Mobile Taiwan](image)

**M-Taiwan Program Status**

- Government allocated $42 million (USD) for the program in 2005
- 23 Proposals were submitted in October 2005, 10 for Mservice (Public sector) and 13 for M-Life (see the project list above)
- 4 M-Service and 7 M-Life proposals were funded to build WiMAX infrastructure in various cities. Among them, VoIP, M-Payment, IP TV, and M-healthcare are the major services to be provided
- The contracts for the funded proposals were signed in December 2005
- Work intensively with companies participating in the program and international organizations on building test centers for products to be used in the M-Taiwan program (Acer Inc. Chunghwa Telecom Co., Ltd. China Television Company, Ltd. Far Eastone Telecommunications Co., Ltd. First International Telecom Corp. Hewlett-Packard Taiwan Ltd. Asia Pacific Broadband Telecom Co., Ltd. Rock Mobile Corporation Taiwan Television Enterprise, Ltd. Tatung Co. VIBO Telecom Inc.)
PROJECTS

“School of the Future” (SOF) project

An example of a successful public-private partnership in m-learning is the “School of the Future” (SOF) project in Taiwan. This project came about through efforts by the Government of Taipei to pursue m-learning and ICT-enabled education. The Government’s holistic and integrated vision involved incorporating the following factors in order to enhance student achievement:

- Public policy support and integration.
- Education policy.
- Curriculum and pedagogy.
- Learning space design.
- Teacher training.
- Innovative technology.
- Research

The partners involved in the School of the Future project included: the Taipei City Government (in charge of public policy and planning); Taipei Bureau of Education; the Teacher Training Institute; Tamkang University; Zhong-Lun High School; and companies from the private sector including Microsoft and Infovision; as well as NGOs. The key driver of the project was a policy imperative initiated by the mayor of Taipei to modernize infrastructure and stimulate economic growth. The city has recently embarked on an aggressive initiative to blanket the entire city with a wireless network involving 10,000 antennae across the city, with the goal of providing 100 per cent WiFi coverage by December 2005. The new mobile teaching and learning programme involved the community and all educational institutions within the city.


Chinese language was usually considered difficult to learn, because of its complicated shape, different pronunciations and multiple meanings. In recent years, the amount of female spouses from Southeast Asia increased rapidly in Taiwan. To acquaint them with local society, some institutions were asked to give Chinese courses regularly. There have been some researches showing that using mobile devices in the course can improve learners’ performance and arouse their motivation. Compared to traditional desktops, mobile devices possess several merits- 1) mobility, 2) instant feedback, 3) interactivity, 4) context awareness. According to the requirements, a mobile environment can make communication between teacher, learner, system and the user’s surroundings. The main contribution of this project is to propose a mobile environment on PDAs for foreigners to learn Chinese. Besides the technological aspects, the investigation into human-computer interaction (HCI) will be stressed through the whole design process.
Concept and design of Ad Hoc and Mobile classrooms (2003)
This investigation describes the concept of mobile learning and the design of Ad Hoc and Mobile classrooms. Four classes of mobile learning and implementation of Ad Hoc and eSchoolbag systems are presented. The paper discusses the development of advanced wireless technologies for building an ad hoc classroom to create a modern and new learning environment. As in a traditional classroom, information technology is developed to provide the teacher with aids, such as a blackboard, a board rubber, coloured chalk, a microphone, a voice recorder, a video recorder, and so on, to support teaching and discussions.

Handheld devices with large shared display groupware to facilitate group interactions (2007)
One-to-one computing environments change and improve classroom dynamics as individual students can bring handheld devices fitted with wireless communication capabilities into the classrooms. However, the screens of handheld devices, being designed for individual-user mobile application, limit promotion of interaction among groups of learners. This study proposes a design of classrooms that incorporates personal workspace and public workspace. Students use handheld devices as private workspace and work with peers on public workspace with shared displays through their handheld devices. Experiments confirmed that students with only handheld devices did not demonstrate expected participation ratios and actively interact with group members. The proposed shared display groupware promoted shared understanding of the workspace and increased awareness of partner actions. Collaboration was enhanced by creating the opportunity for students to use handheld devices to perform ideal communication patterns and avoiding ineffective communication patterns.

Improving experiential learning with mobile technologies (2005)
The study designed a system and a flow of learning to motivate and guide students to conduct experiential learning with mobile technologies. Students of two classes of fifth-grade at an elementary school participated in the experiment. Thirty-four students of one class conducted learning with PDAs in a school garden while thirty-two students of another class conducted in a condition without PDAs. The data shows the advantage of support with mobile technologies for the acquisition of knowledge. Most of the hypotheses are confirmed in the study. These findings show just how important mobile technology is in helping to improve the learning achievement of experiential learning.
SOUTH AFRICA

Work at the University of Pretoria led by Dr Tom Brown, now at Midland Graduate Institute, and at Tshwane University of Technology led by Professor Herman van der Merwe gave South Africa a leadership role in the field of mobile learning which has now been built on by other institutions in the country. The University of Pretoria work provided mobile learning for students enrolled in a Post-graduate Diploma in Education who were all teachers in rural schools in South Africa. These students had no access to email or to e-learning but all had mobile phones which were used successfully by the University in their education.

TELECOMMUNICATIONS INFRASTRUCTURE IN SOUTH AFRICA

South Africa hosts the largest mobile market in Africa, with nearly 36 million connections. There is still plenty of growth to come, as market penetration is only at 72%. However, the competition is intensifying. In 2006, Virgin Mobile entered the market as an MVNO and mobile number portability was also introduced. Until recently, South Africa’s mobile market had only three mobile operators, Vodacom, MTN and Cell C, along with a few large service providers - the biggest of which are Nashua Mobile and Altech Autopage. Although the number of players is increasing, the market is still dominated by Vodacom and MTN, the two largest operators.

In South Africa, mobile data usage is low. There are moderate users of mobile data services, but these are largely based in the developed regions. In some rural regions schooling may be limited and therefore a large majority of people - of all age groups - are unfamiliar with using technology, which severely reduces the demand for mobile data services. If operators are to grow mobile data revenues in these regions, they must first educate these customers on the benefits of mobile data services.

Despite low demand for mobile data services, both Vodacom and MTN have invested heavily in building and upgrading their 3G networks. The South African market and other emerging markets are different from highly developed markets, for example, a large amount of people will not have the comparison with fixed high-speed broadband technology or the ‘free’ mentality that many Internet users in developed markets retain. This may assist the take up of mobile data services in South Africa.

Africa subscribers are forecast to grow at a Compound Annual Growth Rate (CAGR) of 23% over the five year forecast horizon, while handset shipments are expected to grow at a CAGR of 66%. South Africa has already begun its commercial launch of WCDMA, but most of the other regions are still buying first-time, entry-level phones. Africa and India are perceived as the markets in need of the ultra-low-cost, entry-level phone. The region exhibited a large replacement market, at 44% last year, but is expected to decline in 2007 to 32%. The number of mobile users is often much higher than the actual
number of phones, as many people allow family and friends to use their phones (Vodafone.com/Africa).

Mobile penetration is already saturated in the urban regions of South Africa. Operators are thus turning their focus to the rural regions, where future new mobile customers are more likely to come from. Statistics from Euromonitor state that in 2005 around 45% of the population lived in the rural regions, representing 22.5 million people. In addition, a large proportion of the rural population still does not have access to mobile or fixed communications.

MOBILE LEARNING AT UNIVERSITY LEVEL

TSHWANE UNIVERSITY OF TECHNOLOGY

The Tshwane University of Technology (TUT) is the largest residential university in South Africa. Students represent all cultures and the eleven official languages of the country. The purpose of this report is to share research on a pilot project to integrate mobile technologies (PDAs - Personal Digital Assistants - and cell phones) with an eLearning environment (eLMS) in Ecotourism.

eLearning coursework was created on WebCT and presented in an online environment. Learners in Ecotourism also undertake field trips into nature as part of their practical training, after which a project is submitted for evaluation. During these field trips the learners work in a cooperative learning environment to gain practical experience of the theory. They receive assignment questions and have to collect information during the trip. Prior to the excursion the educator transfers assignments, tests, relevant information, references and multimedia programs (e.g. Roberts Birds) to the PDA. Learners use PDAs to take notes, find information, write tests, and prepare the final project.

This research will be to determine how eLearning, e-testing and mobile technologies can contribute to a successful 'outdoor' learning experience for both educator and learner. The population for this study includes learners of two different subject groups, Biology I and Wildlife Management II.

The main research question to be answered is: How can the use of mobile technology support and enhance field learning?

Sub-questions include:
1. How can field experiences be enhanced by the use of mobile technology?
2. How does the use of mobile technologies motivate students to improve their learning?
3. How do students take advantage of and benefit from the tools offered?
4. What features should the mobile computing systems provide?
5. How do students at various levels of experience use the resources?
6. Which assessment methods are appropriate for mobile technology?

Feedback from learners confirms that the use of mobile technology can support and enhance their field learning experience in a number of ways.

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.

UNIVERSITY OF THE WITWATERSRAND

One Laptop Per Child (OLPC) is an initiative to bring education to every child. The OLPC project seeks to provide a laptop with flash memory for each child, for a relatively low cost. The project targets children in developing countries and rural or poor communities. The OLPC is neither a hand-held device nor a commercial laptop, but is certainly mobile. The advent of the OLPC raises the question of what is the “Knowledge-Base-of-Material-to-be-Explored-and-Soaked-up”?

The One Encyclopedia Per Child (OEPC) is a locally initiated scheme to incorporate the best reference material into the OLPC. This article documents the initiative, whose off-line content is based on the on-line articles in the Simple English Wikipedia and the English Wikipedia. With such encyclopedias children can become self-motivated lifelong learners. OEPC is arguably the most important content that can be pre-loaded on the OLPC.

To explore the possibilities, Kennedy (2007) created an OEPC prototype. What a child really needs to learn with is nothing more than an encyclopedia and a simple way to navigate it, but it is not feasible to store an entire encyclopedia in the available space. Nevertheless, through selective entries and appropriate content, a workable OEPC is possible. Production of One Encyclopedia Per Child mainly in Simple English was first advocated by Kennedy (2006). The solution advocated was a small corpus in Simple English, suitable for ultimate downloading to the One Laptop Per Child. Wikipedia has published a list of articles that all language editions should have, which forms a useful core of topics. The process of automating the selection of articles advocated was to use a network centrality approach to determine which central articles should be included from the Simple English version of Wikipedia. Using The Simple English Wikipedia ensures greater comprehension by the target children, and greater exposure to more topics. A front page was later created by Kennedy et al (2006) for the OEPC.

Much research remains to be done on validating the suitability of the vocabulary, language level, and of the appropriateness of the encyclopedia entries. Work needs to be done on editing the encyclopedia articles to ensure that they satisfy the children’s expectations. Educationalists need to augment the encyclopedia articles with educational exercises and examples. Field research must be done to establish the degree of usability and usefulness.
Wireless and social networking problems must be sorted out. Longitudinal studies need to be performed to establish the effect of the intervention on uplifting the education of the community and ultimately in reducing poverty.

**UNIVERSITY OF CAPE TOWN**

With over 98 percent of students with cellphones, the project seeks to exploit devices already in student hands to provide anywhere anytime student support. Anecdotal evidence shows that texting is the students’ modulus operand method of communication. Although each registered student has an email account, the frequency of email use is increasingly dismal among students. As a consequence, urgent emails to students usually followed up with a text message due to long lead time between sending an email and having it read. Thus, the Short Message Service (SMS) broadcasting is a basic activity among academics using an SMS Broadcasting Tool.

The Dynamic Frequently Asked Questions (DFAQ) - allows students to anonymously ask and receive answers to questions they could otherwise not ask in face-to-face session. Designed with a seamless Web and Mobile interface, the anonymously created artefacts become a resource to the entire class and also serve as feedback to the academic on student learning.

A Virtual Noticeboard - allows academics to post announcements and students use mobile phones to access the noticeboard on demand.

Collaborative Glossaries - allow students to collectively create short notes (e.g. acronyms, definitions etc) and the resulting repository is accessible through texting.

An Event Notifier – allows an academic to plan messages about notifications, reminders, deadlines etc in advance (e.g. for the whole semester or year) and the tool sends notifications to students at scheduled times.

All the above tools are designed and developed at the Centre for Educational Technology, at the University of Cape Town.

**UNIVERSITY OF SOUTH AFRICA (UNISA)**

*Taking the Distance Out of Distance Education through the means of mLearning*

How do you react when you receive a short message system (SMS) from the university where you are enrolled? You probably would feel excited to be part this new adventure called learning, which is described as “The success of the beaming process is increasingly measured by the high number of satisfied customers and low number of drop-outs, and not pedagogical imperatives”.

“A course is much more than a package of study materials... they (the learners) must be supported in various ways. They may be distant from their teaching institution, but they must not be isolated”.
The aim of this report is to determine if learner support through mLearning will help the learner to feel less alienated and to see how SMS's can be best implemented in the Distance Education environment so that it is beneficial for all learners.

One of the most effective means of support in the distance learning environment is to make contact with the learner, anything that will bring the lecturer and the learner closer together where there could be a “meeting of minds”. As this student struggles to cope with all this information as well as the demands of learning by a distance they come to realize that they need help, so much so that without intervention they might drop out.

Through mobile support, learners' throughput rates might be improved and the quality of the learning experience enhanced. Active learning might immerse where previously inactive studying took place.

Unisa has approximately 200 000 learners. The widespread availability and use of cellular phones have provided unique opportunities to the University of South Africa and its students. This means that Unisa students could receive and send SMS messages. Unisa has therefore decided that this technology should be used to improve the communication to learners. Areas such as learner support and administration (finance, exams, library, and dispatch) have been identified as obvious targets for this initiative.

The demography of the Unisa learner community is very diverse in terms of location (urban, rural and international), language, and cultural background. Although the main medium used by Unisa to communicate with learners is currently conveying paper-based material through the postal mail system, the Internet and e-mail is also used. The introduction of the SMS technology would be a more direct means of communication between the university and its students therefore improving efficiency of services.

This report provides an overview of the Mobile Communications project with specific reference to SMS services for students. It will cover the various application areas for SMS and services that are currently available and being planned. The existing infrastructure and the implications to the university's processes and systems are also covered.

REFERENCES


The data collected by the project show that the Republic of Korea and China have the infrastructure to become world leaders in mobile learning.
REPUBLIC OF KOREA

The Republic of Korea is in the forefront in Asia and in the world in adopting new technology for learning. For instance, it has been far ahead of Japan in introducing broadband access in the homes. The Korean government has actively tried to influence the development of Korea into an ubiquitous learning society. There are a number of factors promoting mobile services for learning in the near future. There are examples of mobile learning activities on all educational levels. The Ministry of Education has including mobile learning as one section of the nation-wide educational software contest. Korean universities encourage the development of Internet learning that uses mobile technology and both elementary and secondary schools use mobile technology in learning.

E-LEARNING IN KOREA

Similar to Japan, Korea is a country in the forefront in Asia – and in the world – in adopting new technology in general and for learning. E.g. it was far ahead of Japan in introducing broadband Internet access in the homes (Murakami 2003). According to Korean statistics the number of students per PC in technical high schools has been around 2 students per PC already since 2002 (in ordinary high schools around 5 and in elementary schools around 7) (KERIS 2006). According to the same statistics Korea was in the absolute top of the world in students ICT use in schools (ibid. p. 25).

The Korean Ministry of Education & Human Resources Development has promoted the adaptation ICT in education and development activities under a five year plan from 1996, in order to encourage the effective utilization of ICT in education. The goal of the three-phase development plan is to promote the next generation adapting ICT in education projects on the basis of accomplishments from existing ICT in education activities and to realize the u-learning society and “Creative Korea.”

MOBILE LEARNING IN KOREA – PRESENT AND FUTURE

The following account of mobile learning in Korea is largely taken from Baek & Cheong (2005). The rate of mobile phone subscriptions has increased rapidly since 1999 and is comparably very high in Korea. According to a national survey of September 2004, the percentage of mobile phone users who used the wireless Internet at least once within the previous 6 months was 40 percent and this rate is increasing. However, the survey also revealed that it was very little educational content available for the wireless Internet, and also that overall user satisfaction rate is very low. In addition the speed is slow and at the same time the service charges are high.

In spite of the negative aspects, Baek & Cheong point to a number of factors that will promote mobile services for mobile learning in the future:
1. New types of wireless communication services will soon be widely available, e.g. a digital multi media broadcast service that combines broadcasting with digital communication.

2. Technological development in mobile semiconductors such as flash memory that makes mobile devices smaller, more capacious, and highly powered. This enables mobile phones to absorb the functions of digital cameras, MP3 players, and game machines.

3. Connected wired & wireless Internet services are popularized by the Internet portal sites. This enables mobile contents to be more plentiful for mobile learning.

4. Fixed charge payment system for the wireless Internet services offered by one provider (2005) will likely stimulate the competing providers to upgrade their own systems.

5. Students use the wireless Internet more than graduates. This is an important factor suggesting the likelihood that mobile devices or the wireless Internet could be used to assist their learning.

6. The number of mobile phone users appears to be constantly increasing. The number of domestic mobile phone users in Korea in 2010 is predicted to be more than 35,540,000, or 81.3% of the nation.

Baek & Cheong also refer to the u-Learning project mentioned above as one example paving the way for future mobile and ubiquitous learning in Korea. The Ministry of Education and Human Resources Development has also included a mobile section in the nation wide “Educational software Contest” 2005. The goal of the contest was to create more interest in e-Learning in real circumstances and to promote u-Learning (MOE & HRD 2005).

According to Baek & Cheong Korean universities encourage solutions for information and mobile Internet learning that use mobile technology. E. g. the mobile library, where students can search for books, authors, publishing firms, new arrivals et cetera with PDAs. The mobile library also offers information on such things as personal lending, subscriptions, return dates, and book requests. Furthermore, they are attempting to make their campuses mobilized.

In Korea, there are also some elementary and secondary schools that use mobile devices in learning. One elementary school in Seoul runs classes using the Internet as an instructional tool with wireless LAN laptop computers. It can encourage students to question and debate one another armed with information they have searched. There is also one elementary school that offers SMS to parents of daily or weekly, which includes comments on teaching-learning, guidance and classroom management.

There are also examples in Korea that domestic mobile phone service providers have aligned with education service companies, and are entering
into the market for connected wired and wireless Internet educational services with mobile devices, such as PDAs and mobile phones.

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CHINA

China is not yet a country of mobile learners, but it has all the potentials to incorporate mLearning into mainstream education in the future. The mobile telecommunication sector is rapidly growing, just like the rate of internet access within the population. The coastal and the special administration areas are very well developed, but the great inland territories still need a tremendous amount of infrastructural investment. There are several companies, universities, research institutions active in the field of ICT supported learning, providing a good basis for valuable research activities.

MOBILE TECHNOLOGY

China’s telecommunications sector continues to be dynamic across most segments of the market. With the mobile sector still expanding at close to 20% annually coming into 2007, the long-awaited licensing of 3G services is getting closer and will surely give the market yet another boost. There remains a continuing need for major industry restructuring and there are expectations that the government will take action on this front in conjunction with the issuing of 3G licences.

With all eyes on the telecommunications market in China, there is no doubting its substantial growth momentum and potential. Nevertheless the market presents many contradictions. Telecommunications in China can be characterized by creativity and daring one minute, and by caution and procrastination the next. In fact, it is often out of step with what is happening in other parts of the world. With the Beijing Olympics in 2008, telecommunications development has continued to figure prominently in the nation's priority scheme as China prepares to showcase itself.

Hong Kong

Hong Kong has developed a reputation as one of the most sophisticated and dynamic telecommunications markets in the world. This Special Administrative Region (SAR) of China has built itself a world-class telecoms infrastructure, supporting a high penetration of mobile phones and telephone services generally.
At the start of 2007, the territory had over 3.8 million fixed telephone lines in service, for a teledensity of around 54% - one of the highest fixed line penetrations in Asia as well as in the world. While the fixed-line market has certainly been leveling off, the mobile market has continued to be a boom sector. According to Office of the Telecommunications Authority (OFTA) data, by April 2007 there were a mind-boggling 9.3 million mobile subscribers in the SAR; this represented a mobile penetration of 135%.

**Macau**

Macau also a SAR of China, has remained very low profile compared with Hong Kong in the development of its telecommunications market. With a similarly strong commitment to providing quality telecommunications-related services, however, Macau has systematically built itself a strong modern telecommunications infrastructure. The result is another highly penetrated telecoms market.

Fixed lines reached a saturation point at a little over 35% teledensity a few years ago. Attention then shifted to focus on the mobile market, where, by early 2006, there were 563,000 mobile subscribers, a penetration of 113%. But it did not stop there. Twelve months later, by April 2007, the number of mobile subscribers had increased to 684,000 and as a result the penetration had reached an amazing 137%. This made Macau the most highly penetrated mobile market in the world at the time.

**Key highlights**

- China has the world's largest mobile subscriber base, passing 450 million in early 2007; in addition to this there were more than 90 million "Little Smart" limited mobility services.

- The country's largest mobile operator, China Mobile, is the world's largest in terms of subscribers; having passed 300 million in December 2006, it was still growing at more than 20% coming into 2007.

- While overall broadband Internet penetration remains low (4%), the number of broadband customers passed the 55 million mark in early 2007.

- China is ranked number two in the world behind the US in the number of broadband subscribers and is on track to become the world's largest broadband market.

- China already has the highest number of DSL subscribers in the world (37.1 million subscribers by end-2006, followed by the US with 25.7 million).
• China has the largest number of fixed-line subscribers and VoIP users in the world.

• China has the largest cable TV network in the world.

• China's terrestrial TV services reach approximately 95% of its 380 million households.

• In its push for digital TV, the Chinese Government intends to end analogue TV broadcasts by 2010.

• Preparation for the 2008 Beijing Summer Olympics were continuing in earnest into 2007.

• Hong Kong and Macau both continued to have booming mobile markets; by early 2007, they were the leading mobile markets in Asia in terms of subscriber penetration.

- Macau was #1 (in both Asia and the world) with 146% penetration and Hong Kong had 114% (end 2006 figures).

• In Hong Kong, 1.5 million 3G customers had been signed up by the operators in just over two years from launch; this represented 16% of the total mobile subscriber base.

• The 2005-2006 period also saw a surge in Hong Kong's broadband Internet market with subscriber growth running at an annual rate of around 50%.

• Hong Kong continued to promote competition in the telecoms market, with the regulator OFTA proposing further reforms.

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PROJECTS

Learning Chinese
Chinese is usually considered difficult to learn because of its complicated shape, different pronunciations and multiple meanings. Recently the amount of foreign spouses from East Southern countries is increasing; this raises some critical problems. In order to remove the obstacles caused by different cultures and help these female immigrants express their own opinions, Chinese ability indeed is an important issue to consider. Therefore, a study has been developed by the Government about a learning environment for Chinese language learning on PDA by scenario-based evaluation methods, and will focus on the human-computer interaction issues on mobile devices and integrate suitable teaching strategies for adults.

Research on the Communicative Mobile English Learning Model (2008)
Primary school English study presented here is as follows. Students mainly conduct independent extra-curriculum learning with mobile devices by using learning resource packages which are interactive, close to the scenes of the content and also great fun. Additionally, various interactions of role play, such as teachers' tutoring, parents' expectation and peer learning are also included as supplementary. Multi-evaluation, with its emphasis on evaluating the whole process, is conducted all along the courses.

In this mobile learning model, students are the subjects of learning. Learning resources and learning activities are used to arouse students' desire and interest for independent learning, handbooks are used to record the learning process and evaluate the effectiveness of learning, students’ self-evaluation, teachers’ evaluation and parents’ evaluation are also jointly considered to check the learning process, evaluate the learning effectiveness, and motivate the learners. Teachers' tutoring helps to solve students’ questions, and provide a face-to-face communicating environment; while parents’ timely involvement and the caring of family members can strengthen students’ motivation in learning.

In the background of new curriculum reform in China, years of research on the application of one-to-one learning in in-class teaching has been done and some achievements are made. For instance, the Innovation Exploration Test For Leapfrog Development in Primary Education project in Beijing Normal University focuses on how to perform in-class teaching in one-to-one learning mode in network environment. This project equipped each student with a laptop computer with network connection, which can provide access to kinds of learning resources. Teacher-oriented and student-centered in-class
teaching are performed which proposes to treat information technology as tools of cognition and emotion stimulation, breaks the limitation that the textbook is the sole knowledge source and brings students into the infinite exploring space constructed by computer network. It greatly enlarges the students’ knowledge scope, deepens their cognition engagement and promotes their development of all aspects including high-level thinking ability.

Out-of-class one-to-one learning takes two main forms. One is mobile learning based on short text messages; the other is mobile learning based on connections. The former style is the simplest and most widely studied mode, where learners send short text messages to teaching servers through cellphones, PDAs or other handheld devices and then teaching servers convert the short text messages into data requests and then data are sent back to learners. Many researches on solely in-class or out-of-class application of one-to-one learning have been done. However, work on application of one-to-one learning combing both in-class and out-of-class teaching are rare, especially on the subject of Chinese classical poem education.

The Development of multimedia-based mobile learning system (2005)

Mobile Learning is just entering China’s K-12 and higher education. Although the use of mobile devices in education is still in its infancy, there have been a few exemplary cases of successful use in schools. Several K-12 schools participated in a mobile inquiry program about birds; and several others use mobile devices for students and teachers to exchange short text-messaging. In higher education, leading institutions have attempted to create mobile virtual classrooms. The E-learning Lab of Shanghai Jiao Tong University (SJTU), for instance, has successfully delivered sample broadcasts of its online courses onto cell phones and PDAs. These learning settings support a college-level English course of about 50 on-campus and 30 online students.

Another project designed and implemented a real-time multimedia mobile learning system. Through the GPRS network, the whole scene of a real-time classroom can be broadcast to the smart phones based on the Symbian operating system, which enables students to access teaching and learning activities occurring in a real-time classroom, and also the frequently updated learning resources anytime and everywhere. Meantime, by researching and implementing multiple means of user interaction, the system effectively enhanced the interaction among instructors and students in a mobile learning environment, which is a help to improve the teaching quality and learning outcomes, two of the major issues that are key to China’s mobile learning. The work was supported by the STCSM’s key research project: The Development of multimedia-based mobile learning system. Project Number: 03DZ15016

Department of Computer Science and Engineering

The growth of wireless networking and the maturing of online learning have created an environment in which students are mobile and learning is no
longer tethered to the classroom or the laboratory. A mobile learning platform has been developed, which supports multi-media courses delivery and has been applied in Network Education College of Shanghai Jiao Tong University. Based on the platform, an assistant system to solve the learning status monitoring issue which is becoming a challenge of learning effect control in mobile learning was proposed. This assistant system can enable teachers to monitor the students’ mobile phone screen synchronously thus knowing the learning state of the students, and it also supports real time interaction with the students by instant messages. Meanwhile, the students can view the status of other online peers, interact with each other and ask for remote assistance by sharing their own screens to those willing to help. Supported by National Natural Science Foundation of China under Grant No.60372078.

Supporting real-time collaborative learning with web-based groupware (2005).

The Wireless Online Tutoring System (WOTS) is a web-based, synchronous groupware system that has been developed to facilitate student collaboration in group projects. It supports interactive and collaborative structured-diagramming and is equipped with group awareness features such as remote cursors, locking, and text-based instant messaging. Users can access WOTS from both personal computers and handheld devices, allowing it to be used in wireless classrooms or distributed environments. Tests on student software design projects validate the ability of WOTS to support student collaboration in group projects, and show that its architecture is scalable and reliable. Its performance is expected to improve as more powerful handheld devices and wireless technologies come on to the market.

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The data collected by the project show mobile learning activities in Australia, Canada, India and the United States of America as well.

AUSTRALIA

Current mLearning initiatives within the education and training sector of Australia are characterised by fragmentation. Several universities and
education faculty staff have pockets of research, initiatives and enthusiasm; however their work is essentially focused on the Higher Education sector.

There is considerable interest in exploiting the almost universal appeal and abundance of mobile devices for their educational use. The Internet is increasingly considered as, and is being used as, an educational tool accessible via these devices. Devices have become more portable, affordable, effective and easy to use and increasingly connect users to a wide range of information services and educational opportunities. They are more cheaply priced than desktop computers, and therefore represent a less expensive method of accessing the Internet, although the cost of connection can be higher. The universal nature of mobile devices provides opportunities for increasing participation and access to ICT and its usage for educational purposes.

MLEARNING PROJECTS

TxtMe Project, Swan TAFE, WA (2004)

This project targeted 15-19 year old students who had not previously succeeded in traditional classroom-based learning, and examines the option of mLearning for vocational education and training (VET) providers. The project was funded by the Australian Flexible Learning Framework as a New Practice in Flexible Learning project, developed collaboratively between stakeholders in five TAFE (Technical and Further Education) Colleges in WA.


This Queensland-based project was inspired by the ongoing advances of handheld mobile technology and the potential of this technology to provide a valuable addition to the flexibility of training delivery. Its focus has been to provide new directions in the way in which handheld technology is used in the delivery of training in the workplace through the development of innovative resources and teacher support materials including Learning Objects that are best suited to handheld delivery.

mLearning Network - Institute of TAFE Tasmania, and Swan TAFE, WA

The mLearning network provides a community of practice aimed at furthering the ongoing knowledge and development of mLearning in Australia and as a hub to foster mLearning connections internationally. Its fundamentals are based around the new and emerging mobile technologies, including but not limited to mobile phones, Pocket PCs, Palm PCs, PDA’s, Tablet computers plus other mobile devices and their potentials for the flexible delivery of learning. Its aim is to build a unique network of like-minded practitioners from private and public practice to enable the sharing of innovative mLearning concepts, ideas and experiences that provide support for best practice mLearning.
CANADA

The use of mobile technologies (laptops, iPods, PSP, GPS, Mobile phones) in Canada has increased and is present in all contexts of life. Communication conversion is underway and the use of m-learning for students located in remote places is taken as an advantage for communication and for media content development (text is getting less important). There is a wide cross-section of Canadian academic institutions engaged in the research of mobile technologies and a number of those are researching m-learning.

The main players are dedicated to the development of learning content that can be downloaded from a library and accessed via iPods and mp3 players (mobile devices without interactivity features) and also accessed via PDAs (with real interactive features). Important research work was done since 2001 on content development for different mobile devices and screen sizes as well as the use of GPS for location based learning and content production. Design for small screens theory and pedagogy are also on the edge of the research. M-learning development in Canada seems quasi-exclusively based on the academic level research; corporate m-learning developments were not found.

A recent report *M-Learning in Canada* by Mohamed Ally & Simone Laughton (issued in August 2006) refers to the main issues on research and development in mobile learning and is the most up-to-date document found on the state of the art in Canada.

The 44 mobile learning papers reviewed for this study, representative of Canadian mobile research efforts, are merely a brief introduction to academic, government, and corporate research activity in the field of mobile technologies within Canada. The results of the literature survey indicate that there is a wide cross-section of Canadian academic institutions and associated research laboratories engaged in the research of mobile technologies. Of the 44 academic research papers reviewed over 24 contributing Canadian academic institutions and research laboratories were identified, and these were geographically dispersed throughout the country.

PROJECTS

*Mobile Learning in Athabasca University*

McGreal states that in Canada, the first short experiment took place in 2001, conducted at the Northern Alberta Institute of Technology and using PDAs (Since then, different universities have been experimenting with podcasting of lectures.

Athabasca University, which hosted the International Mobile Learning Conference in 2006, is leading in mobile learning research where it has created a mobile-enabled digital reading room with materials accessible using a variety of different mobile devices [http://library.athabascau.ca/drr/] (McGreal, Tin, et al. 2005).
Ally and Koole (2006) have been experimenting with the usability of a wide range of mobile devices, including the new ultra computers such as the OQO, PDAs such as the Sharp and Treo and portable boxes like AMD’s Personal Internet Communicator and the Mac Mini.

EDUCAM Project (2004)

The EDUCAM Project (EDUCation par Apprentissage Mobile) was conceived in 2004 and developed by CFORP-SAMFO, for the 12 francophone school boards of Ontario, in partnership with the NRC (Moncton).

Pedagogically driven, the objectives of the EDUCAM pilot-project was to evaluate if the use of a mobile device (PDA) used as a learning tool, could contribute to motivate students to learn, enhance communication and collaboration learning through mobility and accessibility and reduce in the same time pressure on existing IT resources in schools (IT labs). Through surveys of principals, teachers, and guidance counsellors at different school boards and schools across Ontario, a course, Introduction to Anthropology, Psychology & Sociology, Grade 11, University/College preparation, was selected for the project. Original content was produced, existing course content adapted, and learning objects were identified for conversion and re-use.

University of Toronto Mississauga

The value of M-Learning has been especially illustrated in the growth of Global Positioning Systems (GPS) in many academic areas across the curriculum. With the linking of locational data (coordinates, place names, etc) with their field data through the use of a GPS, researchers can analyze and illustrate their research in many new ways. For example, using a GPS device, a Ph.D. candidate collected fish and benthic invertebrates from Lake Huron in Northern Ontario. Included in the data collection were the location coordinates of each sample. Plotting the location of these samples onto a digital bathymetric map of the lake with the depth contours highlighted, the researcher was able to spatially and visually represent the samples and lake depths, further strengthening the research.

REFERENCES


Companies in India are receiving contracts for the development of mobile learning materials from institutions in Europe and in America. Two examples of these mobile learning development companies are given here: ZMQ Software Development Systems and Aptara. Examples are given of India’s academic contribution to mobile learning with the participation of the Management Development Institute and Birla Institute of Technology and Science to the Editorial Board of the International Journal of Mobile Learning and Organisation.

ZMQ Software Systems, New Delhi

ZMQ Software Systems (www.zmqsoft.com) is an Innovative Software Solution Provider specializing in customized M-Learning, Gaming, Edutainment, Knowledge Management and Human Performance solutions. ZMQ has capabilities to deliver solutions on a wide variety of technologies from Internet based Community Learning Systems, Intranet based Closed Net Learning, Stand-alone Learning (CBTs) to Compact Learning on Hand-held & Mobile Devices.

ZMQ has identified mobile as a major platform for information dissemination, whether its learning, gaming, edutainment or infotainment. ZMQ’s m-Learning solutions are in the areas of Courseware Development & Authoring, Simulated Laboratories, Health, Environment, Multi-cultural & Educational Games, Quizzing Systems, Virtual Tourism and Social Learning Solutions. Some of the key solutions developed are Mobile Virtual Classroom, Mobile Human Performance solutions, Educational Mobile Games, M-Learning Infrastructure and distribution system.

APTARA, Pune

A leader in Digital Content Transformation and eLearning solutions, Aptara develops custom content for the eLearning courses, hosts content on companion Websites, and employs latest technologies to repurpose content to various formats. We also target content for Personal Digital Assistants (PDAs), online learning, online quizzes, blended learning, technical documentation, interactive simulations, and corporate presentations. This experience enabled us to explore various content creation and deployment technologies that are currently available and MLearning is one of them. While wireless technology is new and emergent, its application to teaching and learning in college classrooms has the potential to offer significant advantages. It is also an avenue being explored by corporates to distribute information and MLearning for executives is on the move. High-end phones are used which can display documents and run applications and training.

One of the main challenges impeding widespread adoption of MLearning is pedagogy. In a handheld-centric classroom, students’ documents should play a central role which implies major changes in curriculum, instructional
practices, and assessments. The network, bandwidth, and device constraints also pose a lot of challenges in designing the Mlearning content.

**UNITED STATES OF AMERICA**

The use of mobile learning in the US has increased in recent years. A variety of devices are used and m-learning solutions are offered in corporations and universities. An increasing number of small companies are operating in the field of m-learning (such as Moving Knowledge, Instacy, Vcom3D, Hot Lava, LiquidTalk and others), developing systems and contents and this proves that m-learning is already in business.

In a number of US universities the web portals are sending administrative SMSs to their students and the PDA portals open new channels of communication based on mobile content. Pod-Casts are increasing and many teachers pod-cast their classes (see for instance the iTunes University).

The medical sector uses m-learning heavily and some projects have proved that m-learning courses can be developed based on raw content materials that exist in specific digital repositories.

The US military and government are seriously funding m-learning and look at research into both wearable computing and ways m-learning can be used for knowledge management and for just in time learning applications.

One of the main strategies for the development of the m-learning field in Universities seems to be based on the availability of devices for students free of charge. The Universities are offering iPods, MP3 readers, PDAs or other recent devices to their students. Those devices have already pre-loaded contents with university based information and then students can use them to download other files from the University Library, or from the university portals, or from the teachers podcasts or from any other sources. The expansion of use (by students) of the iPod, for instance, together with the iTunes University programme, made possible the creation of a number of projects in Universities that privileged audio and video contents that students could download to their devices, directly from the University Library.

**Podcasts oriented to m-learning features**

The content part of UC Berkeley's commitment to the broadest possible dissemination of knowledge for the benefit of our state, the nation and the world. [http://video.google.com/ucberkeley.html](http://video.google.com/ucberkeley.html)

fitPod.com is the free online community for everything fitness and iPod. It's the place to meet others with similar interests, pick up fitness tips, discuss fitness and music, and share your favorite fitness playlists — what we call "fitLists." [http://www.fitpod.com/](http://www.fitpod.com/)
Fonpods transforms your cellphone into a mobile entertainment and information system. Fonpods is a free, on-demand service that brings podcast listening to any phone. http://fonpods.com/

Melodeo, Inc. is dedicated to bringing consumers the best selection of on-demand podcasts, radio and soon video for PC and mobile phones. Combining social networking, powerful content and access from any device, Melodeo makes it easy to keep up with the world and share entertainment, music, news and views with friends. http://www.melodeo.com/

HearHere lets one quickly find the portions of an audio or video podcast that interest you. http://www.pluggd.com/demo/


Mobility and Mobile Learning - Using portable computing devices (such as laptops, PDAs, smart phones, and tablet PCs) with wireless networks enables mobility and mobile learning. Mobility allows teaching and learning to extend to spaces beyond the traditional classroom. Within the classroom, mobile learning gives instructors and learners increased flexibility and new opportunities for interaction. Mobile technologies support learning experiences that are collaborative, accessible, and integrated with the world beyond the classroom.

MOBILE LEARNING IN THE US: CONCLUSIONS

According to David Metcalf the US is behind much of Europe especially Scandinavia, Japan and other countries that have had a single standard in place longer and have been able to develop in a core, single and unified path.

However a significant number of media integration projects and new technologies related to location have some firm roots in the US and are starting to be used in conjunction with both government standards for RFID and GPS and some of the standards put in for safety like the e911 initiative. These are being used more in the corporate realm than they are in the university realm.

Significant pilots have been conducted at places like Duke University, PSU and Wake Forest for specialized disciplines like law and medicine with mobile devices, and also at a number of universities such as Stanford, Duke again and about 65 other schools that have got the ITunes University up and running. They are delivering some of their audio and lecture based content through that conduit.

K12 education has been slow and is still focused on laptops for kids instead of mobile devices. Many schools do not allow mobile phones to be used in any way in the classroom even up into high school. Because of the potential for
learning applications some school districts and associations have been lobbying to take away these regulations and make them accessible as another learning channel.

In the corporate realm many people are seeing the need for just in time training and performance support. In those areas mobile is being used much more widely. Specific projects related to mLearning from the corporate side have involved organizations such as Vodafone building their Vodafone academy, 3Com building their 3Com university, Valero energy, Ameriquest mortgage, Nokia and other military projects. The military and government is starting to fund this more heavily and look at research into both wearable computing and ways this can be used for knowledge management and for just in time learning applications. The Department of Education has been funding this same area as has the NSF to look at new ways mobile devices can be used for learning applications.

There are a host of small companies starting up such as Moving Knowledge, Instancy, and other companies that are moving into the area such as Vcom3D, Hot Lava, LiquidTalk and others that would all represent new development or delivery applications.

REFERENCE

PART 2  A EUROPEAN STUDY OF THE ACHIEVEMENTS OF MOBILE LEARNING TODAY

The project ‘The role of mobile learning in European education’ has completed two major studies of mobile learning. The second of these studies is a European study of the achievements of mobile learning today. It is 300 pages in length and presents data on 28 European countries (the 27 members of the European Union and Norway). Again much of the data is unique, little known and not available elsewhere.

The results of the data collected allow one to rank the European countries in 4 levels with respect to their achievements in mobile learning.

I

At level 1, there can be no doubt that the United Kingdom is the leading provider and a world leader in mobile learning. The United Kingdom has at least 4 areas of provision:

- primary and secondary schools,
- universities,
- government departments and
- corporate providers.

1. Provision at primary and secondary school level is vibrant. This work began with Professor Mike Sharples, then of the University of Birmingham, working with primary school children who recorded and analysed data on PDAs. Hundreds of UK primary and secondary schools attended the Handheld Learning Conference in London in October 2007, and this gave the conference a noticeable school-level focus. Unlike many other countries, mobile learning in the United Kingdom has a distinct school-based flavour.

2. Many UK universities are active in the field. Leaders are the University of Nottingham (Prof Sharples), the Open University which has a mobile learning research group that produced the major book in the field, London Metropolitan University, which has produced extensive mobile learning courseware and the University of Bristol (Dr Wishart) which has produced extensive mobile learning materials for teacher training.

The Institute of Education, University of London

A symposium was held at the WLE Centre at the Institute of Education of the University of London on February 9th, 2007 which brought together leading researchers and practitioners in the field of m-learning in the UK and Continental Europe. Unlike many other events on mobile learning, the symposium deliberately focused on learning, rather than on technology, attempted to take stock of where m-learning was at as a field of research as well as to start to delineate a future research. This is particularly important, I
would argue, in view of the considerable challenges that confront research into m-learning such as: the relative breadth of possible definitional bases, the rapid obsolescence of relevant technologies, its temporal and geographical distributedness, the lack of appropriacy of traditional research paradigms or the complex ethical issues involved.

London Metropolitan University

It is now widely accepted that the use of mobile technologies in education can help to engage and motivate students to learn. Mobile phones are increasingly pervasive amongst HE students, and it is an attractive proposition to make use of these increasingly powerful devices that they carry around with them, for educational purposes.

This report outlines experiences at London Metropolitan University in introducing mobile learning into blended higher education learning, to first-year students taking an introductory marketing module. As a starting point we conducted a survey with students about their ownership and use of mobile phones. Out of 69 students, only 1 didn’t own a mobile. Intriguingly, 55% viewed the university contacting them via their mobile for learning purposes as a positive aspect.

The survey was followed up with a 2nd cohort of students, with similar findings. As a result, we have begun to introduce mobile learning components into the module blend, which consists of weekly lectures and seminars, assessed group and individual projects, and online learning resources including multimedia learning objects. A multimedia message board (mediaBoard) was introduced to support teamwork for a group project. Students can contribute to mediaBoard via their mobiles, by sending SMS messages, MMS messages that include images and audio files, and emails. Submissions can also be made from a PC, so doesn’t exclude those without a mobile phone or who choose not to use it.

We also began to send students weekly SMS learning hints, reminding them about the online resources that could help them, about seminars and deadlines. Feedback from students on the use of mediaBoard was mixed. The vast majority did not use it for their projects, but over half said they would like to use it again. However, they particularly valued the timely learning hints sent to their mobiles.

In light of this initial success, alongside using mediaBoard to support different student groups, we are starting to develop multimedia learning objects for mobile phones using Flash Lite. Prototypes of such objects on PDAs were found to offer a rich, portable learning experience, and if we can offer mobile versions of online resources, we can more effectively provide materials that students can learn from when and where they want to.

University of Nottingham
The University of Nottingham and the Open University are partners in a £1.1m project to help school students learn the skills of modern science. The three year project, funded by the UK ESRC and EPSRC research councils, is developing a new approach of 'scripted inquiry learning', where children aged 11-14 investigate a science topic with classmates by carrying out explorations between their classroom, homes and discovery centres, guided by a personal computer.

The aim is for children to understand themselves and the world in which they live, through a scientific process of gathering and assessing evidence, conducting experiments and engaging in informed debate. The handheld computers, monitored and supported by their teacher, will guide the students through the activities, which can change depending on the profile and input of each individual taking part. Their activities will be based around topic themes - Myself, My Environment, My Community - that engage young learners in investigating their health, diet and fitness, their immediate environment and their wider surroundings. These topics are key elements of the new 21st century science curriculum that requires children to reason about the natural sciences as a complex system and to explore how people relate to the physical world.

Other partners include Hadden Park High School in Nottingham, Icknield High School Arts College in Luton, ScienceScope, a company that develops sensing and datalogging equipment, Nottingham Museums and Galleries, Milton Keynes City Discovery Centre and Gulliver's Eco-Park, Milton Keynes. The project has an international Advisory Panel to provide advice and support.

Research funded by Nokia is underway with teachers using technologies such as laptop computers, PDAs and mobile phones. The purpose of the research is to investigate and disseminate:

- the creative uses of these devices in schools
- emerging teaching and learning methods
- professional development needs
- assessment for learning in new ways
- teachers’ and students’ roles

Mobile Learning Tools for Children with Life-Threatening Allergies is supported by a Cadbury Schweppes Foundation award.

The aim of the project is to design and build useful electronic tools to support anaphylactic allergy sufferers. Here are just a few examples of the sort of things that might be possible.

- Software for mobile phones that could help with use of an Epipen in an emergency.
Small wireless sensors to detect if an Epipen has been used and react; possibly by dialling 999 and maybe also sending a text message to parents.

Games for mobile phones that help and encourage children to learn about their allergens. Or perhaps just simple checklists of alternative names of allergens and lists of safe and unsafe foods.

University of Wolverhampton

The University of Wolverhampton is involved in a range of mobile learning activities:

Messaging: large-scale sustainable broadcast and interactive web-service technologies funded by JISC plus work with ELT teachers in South Africa, large-scale in-service teacher training in Kenya funded by DFID and support for small-scale organic farmers in rural East Africa funded by Lichtenstein Development Agency

Bluetooth: transmitting straight to local learners’ Bluetooth devices on person-specific, location-specific basis: educational content, interactive apps and pastoral support, funded by Graduate School and UK Higher Education Academy

Context Awareness: context-aware, profiled material to visitors/delegates in conferences, exhibition and museum spaces plus forensic science training based on location-aware handhelds in scene of crime scenarios

Handhelds: environmental science field work with undergraduates

iPods: “podagogy” introducing iPods into dance, drama, music courses

Training: national workshops on implementation and embedding funded by JISC, local lecturer training in messaging, handhelds, podcasting etc

The Open University

The Open University is developing a virtual learning environment to provide an integrated, high quality online learning experience for students across the full range of subject areas and curriculum. This development includes work on mobile learning, for users with no fixed point of access, those who synchronise information to mobile devices for offline use, and those who connect ‘on-the-go’. The project is promoting a device-independent approach and has a broad scope of activity including podcasting, RSS news feeds, text-based announcements by SMS, instant messaging, m-assessment, mobile course content, and social and user-generated content on-the-move.

The Open Centre for Excellence in Teaching and Learning (CETL) is made up of four centres and provides insights into delivery of effective life-long learning at scale and free from constraints of time and place. Several mobile learning projects are supported, e.g.:
In the Centre for Open Learning of Mathematics, Science, Computing and Technology (COLMSCT):

- A feasibility study of the use of novel portable technologies for the delivery and studying of course material.
- An investigation of the use of mobile technologies to support students' learning.
- A critical review of the use of enabling technologies for commentary on on-line assessment and on-line tutorials, with reference to both technical aptitude and motivation.

In the Centre for Practice-Based Professional Learning (PBPL):

- Investigating science teachers’ use of mobile devices in workplace settings.
- Using PDAs for staff development: giving academic and support staff the opportunity to experience handheld learning in the context of their personal and professional development.
- Harnessing technology to enhance teaching and learning experiences at a language learning Residential School.

A project has been set up with tutors from ten regions, covering courses from Openings to postgraduate level and across a wide range of subjects. The tutors are developing materials to suit their students and courses, using alternative media that can be accessed by computer and through mobile devices.

Work following on from the EU funded MOBIlearn project has included developing a methodology for capturing, describing and analysing mobile learning based on Activity Theory, and frameworks for acquisition and analysis of quantitative data acquired through ubiquitous and ambient devices, with the aim of extending the range of techniques available to researchers for evaluating theories of informal learning.

Mobile learning research projects in the Centre for Education and Educational Technology (CREET) include:

- Personal Inquiry: An ESRC funded project investigating the development of children's learning in science in formal and informal settings looking at the impact of mobile learning on transitions between settings.
- Practitioners as Innovators: A project investigating the use of mobile devices by education practitioners in teaching, learning, work and leisure.
- Review of projects using Tablet PCs in schools in England, including an analysis of twelve case studies.

In the Computing Research Centre, The LillyPad project is investigating how mobile collaborative technologies can be designed to support and augment integrated inquiry processes both indoors and outdoors, to enable students to switch their attention between physical activities in the field, digital interactions
with a mobile computer and collaborative interactions taking place in a group setting.

Research in the Knowledge Media Institute includes Enabling Remote Activity (ERA), a collaborative project between KMI and Earth Sciences to support geology field trips, with special focus on supporting mobility impaired students.

Birkbeck College, London Knowledge Lab

Recently increasing numbers of pilots and projects have successfully established the idea that mobile learning is technically exciting and feasible and is pedagogically stimulating and credible. Mobile learning does, for example, offer unique opportunities to deliver situated and personalised learning and to reach new learners and disadvantaged communities. In most cases however these pilots and projects have been fixed-term and small scale and mobile learning has seldom become embedded or sustained within institutions or across sectors.

Over the last two years, the Joint Information Services Committee (JISC) have identified mobile and wireless technologies as having considerable potential for delivering, enhancing and supporting learning in UK further and higher education. JISC were however aware of the difficulties and challenges of sustaining and embedding innovation, including these innovations in mobile learning, in large-scale and institutional settings and were keen to explore how innovation, scale and sustainability in mobile learning could be combined.

The projects technologies comprise a generic message broadcasting system with specific interactive messaging technologies for specific subjects. The generic messaging system will provide targeted bulk and individual texting, for all courses, awards, modules and individuals. Tutors and administrators will be enabled to send messages that are scheduled or ad hoc, bulk or individual; these may be operational (for example a lecture cancelled or moved, deadline reminders, library book recall), pastoral (tutee interview) or educational (study guides, exam tips, seminar prep., assessment feedback, lecture summaries).

Graduate School of Education, University of Bristol

The Graduate School of Education at the University of Bristol has run two small scale projects funded by the Teacher Development Agency that have shown the devices can be useful in supporting both learning and teaching and any technical issues resolved. The applications the trainees used most involved information management. These included using the calendar to manage their schedule, using spreadsheets to manage class grades and attendance, and using the word processor to make immediate notes on events. They also used email to keep in touch, browsed the web to support personal interests and took pictures of or videoed class role plays and field trips. However, the successes were limited in that current school culture in England with mobile phone bans prevailing, meant trainees tended not to feel comfortable about using a handheld device in a classroom context. This limited most of the trainees’ exploration of the devices to occasional use.
It is about to embark on another project focusing on the use of PDAs and Smartphones to support trainee teachers in developing as reflective practitioners through the use of e-portfolios. The trainees will be using the mobile version of the online portfolio tool PebblePad to update their profile of competences any time, from school or home, with both text and images. The School’s interests lie primarily in the psychology of mobile learning and in the corresponding pedagogy of using handheld devices for teaching. It follows a paradigm drawn from cognitive psychology, finding explanations based on cognitive constructs such as challenge, control and constructivism to be the most helpful in describing learning by means of handheld technologies.

The University of Manchester

The University of Manchester is a large federal institution and there are pockets of mobile development going on in various departments. Unfortunately a formal research/learning network for this area is yet to be established but it is something I am looking into. In the meantime I can and will comment on my work for MIMAS, a national data centre based at The University of Manchester.

"Stuart Smith is currently looking into the learning opportunities for utilising mobile technologies in learning. He has taken learning objects, hosted at The University of Manchester and investigated different methods of converting these for use with mobile devices. A key question he has considered is how achievable it might be for the interested educational lay person to produce mobile learning materials; the early results are encouraging.

Whilst many projects consider utilising mobile learning centre around one particular device, Stuart's approach to mobile learning has from the start been device agnostic. This is because the work of MIMAS is on a national scale and it is not possible to predict what device a learner may be utilising.

From single learning objects Stuart is currently considering the implications for bringing entire web service, currently available via desktops to mobile devices; the challenges are not only purely technical but also affect usability and accessibility.

3. The government agency LSDA led a major EU project to produce literacy and numeracy mobile learning materials for disaffected youths and its successor LSN is again involved in a major project, MoLeNET. BECTA has also worked extensively in mobile learning.

British Education Communication & Technology Agency (BECTA)

The use of mobile devices as a way of teaching ICT terms in British Sign Language using short flash movies created into short interactive tests using both a static web page and a quiz engine.
The idea of glossaries on the web is almost as old as the web itself. The ability to put movie clips is a little younger and the idea of putting large quantities of clips linked to a text-based glossary is really a product of the broadband age.

The lack of suitably qualified interpreters with additional subject-specific qualifications has occasionally meant that deaf students have less access to the curriculum. However, the Deaf community has not been slow to realise the potential that technology can offer. The phenomenal growth of SMS by Deaf people is a case in point.

The mobile device and with connectivity enabling content on demand in real time to be delivered to Deaf learners or those working with them is a marriage made in heaven. But a challenge for developers made in hell.

This project built on taking existing web based video resources in a website British Sign Language glossary of 1500 ICT terms. In the existing web presence Users could see a short video clip, text definition and image. Users were able to download clips and build their own mini-dictionaries for in-house use of line on a PC. This project took a limited number of videos in existing QuickTime, wmv format and converted them to flash.

The project took a sample from existing site and made an html site that could be run native on a mobile device from a flash card or across the web. The project then took a PDA quiz engine developed by Tribal CTAD and allowed tutors or learners to create there own quizzes to test their knowledge of BSL for specific technical ICT terms

The work followed the following route:

• development and learning from work that’s gone before
• consultation of a community of practice
• evolution of a consensus model of shared terminology
• the research undertaken for collecting the signs and text-based definitions
• technical issues regarding site construction such as search algorithms and video compression
• demonstrate the live site which is both PDA and laptop browser friendly

Learning and Skills Network

‘Next time you see teenagers in a café surfing on a handheld computer, don’t assume they’re playing the latest shoot-em-up game or downloading a chart-topping tune, they could be learning. This is thanks to a new programme, MoLeNET, managed by the Learning and Skills Network (LSN). It is enabling learners of all ages and from all over the country to use everyday gadgets to transform the way they learn.

So far, 136 FE colleges and training providers have signed up to the MoLeNET programme. During 2008 they will be using handheld gadgets such
as PDAs, MP3 players and smart phones to transform the way they teach and inspire learners.

One of the exciting aspects of the project is the range of organisations taking part. Each project is led by a college, but most are working in partnership with other organisations. This means that MoLeNET activity can not be found only in colleges, but in schools, care homes, doctors’ surgeries, hair salons and workshops as well.

The partnership approach has also opened up the project to a very wide range of learners. Dental nurses, engineers, performing artists, hairdressers and car mechanics are among the learners benefiting from the programme. They include 14–16 year olds on Specialised Diplomas, teenagers on apprenticeships, adult learners, families studying English as a second language and people with learning difficulties.

The programme has mobile learning at its heart, so people won’t just be using the technology in the classroom. They will learn and keep in touch with their tutors, while they are at home, at work or wherever they happen to have some spare time, even on a bus or in a coffee shop. A key part of the project is that it transforms the way further education uses mobile technology to reach out to learners, so people using the gadgets outside the classroom will be key to its success.

There are 36 MoLeNET projects – it is probably the world’s largest-ever mobile learning programme. Among the projects is one called ‘M-learning for those who care’, which is led by Bourneville College in Birmingham and aims to improve social networking, skills and employer engagement in the care sector in the area. Another is led by South Thames College and aims to use mobile technology to help fight gun and gang culture.

The Learning and Skills Council has invested £6 million in the programme and the colleges taking part have contributed a total of £1.2 million. The programme is managed by LSN, which will provide a wide range of support to the projects. This support includes advice, mentoring, developing learning materials and providing continued professional development opportunities, so that all the staff involved get the most out of the programme.

The £7.2 million programme is funded jointly by the Learning and Skills Council and the colleges taking part in the programme. It is managed by the Learning and Skills Network.

4. There are a wide range of British companies involved either in the production of mobile learning systems or of mobile learning courseware to run on these systems. These include Tribal CTAD, Handheld Learning, RedHalo, ConnectED.

_Tribal CTAD_
Tribal CTAD specialises in creating resources enabled by technology but driven by pedagogy. We became involved in mobile learning in 2001 with our role as lead technology partner in the original m-learning project (www.m-learning.org) – working with 250 young people who were dropping out of mainstream provision. Our work has expanded rapidly from there, and we are now supporting over 1500 learners (and their teachers) across the UK, in all areas of educational provision, using all manner of devices. We strive not only to exploit the power of mobile technologies, but also to challenge and build on the pedagogies that can be applied.

Mobile learning has gone through several rapid evolutions:

- Is it technically possible to deliver learning via tiny devices? (of course!)
- Is it possible to deliver valid learning on the move? (yes)
- Can that learning integrate with other, broader activities? (again yes)
- Can the experience be tailored to individual needs (yup!)

The evolution has been rapid. We are now at the point where we are able to deliver very valid, personalised, mobile learning experiences. This fits in neatly with the strong messages from the educational establishment to personalise the learning experience. And results from multiple trials across the UK show that mobile learning is ideally suited to this sort of individual learning.

Learning in Hand

Tony Vincent writes and speaks about handheld computing in education. He is co-author of *Handhelds for Teachers & Administrators*, a complete resource for using Palm and Pocket PC handhelds in education. In addition, He has also had a hand in developing dozens of educational applications for handheld computers that are freely available to anyone who wants to use them.

Palm and Pocket PC handhelds aren’t simply organizers—they are fully functional computers that can run a variety of software applications! In fact, they are a great way to put a computer in the hands of every student. Classrooms all over the world are using handhelds for teaching and learning because of their low cost, portability, ease-of-use, and versatility. However, Tony Vincent has other reasons that handheld computers belong in schools. From freeing the computer lab to creative ways to teach parts of speech, he shows how handhelds are great for teachers, students, and learning.

There are tens of thousands of applications for Palm and Pocket PC handhelds. Many of these applications are quite appropriate for teachers and students and many of them are absolutely free! Examples include completing crazy word stories, conducting surveys, simulating pond life, and mathematical games.

Handheld Learning
Handheld Learning Ltd., is a U.K.-based consultancy, software publisher, and catalyst for change in the U.K. educational technology sector. Supported by the government’s programme to invest in the development of U.K. schools and ICT infrastructure, the vision of the company is that within the next 10 years every child will have a handheld or mobile learning device. Its mission is to provide software and services for these devices, from single applications to end-to-end device management and deployment solutions.

As part of this mission, the company has provided tools to bring together an active online, free-to-access community of leading academics, educators, and developers to share ideas, knowledge, and experiences. Thoughts on mobility show wireless connectivity is going to get faster and more pervasive, online storage is going to get larger and even cheaper. Put these enablers together and we'll experience the true meaning of “mobility”.

Mobility isn’t about a mobile phone or a handheld computing device; it’s about the individual being mobile and their digital content following them; accessible anywhere, anytime and from a variety of devices.

Driven by consumer demand for products such as high-definition television and bandwidth intensive social networking systems this digital “utopia” isn’t as far away as some may think. Embrace or forbid maybe a cliché but it’s inevitable that the continued advance of technology and the way in which the young have already embedded it within their lives will have a profound impact on how they perceive what ICT is and means to their lives. Perhaps the real digital divide is between the establishment and the learners themselves?

Redhalo Limited

The mission of RedHalo is to provide ‘universal access to personalised learning spaces for life’. RedHalo is an online service for learners, educators and parents. RedHalo provides every learner with a free, secure online personalised learning space that they can use to collaborate with teachers and other learners. Truly mobile, the RedHalo learning spaces are accessible via the Internet at anytime, anywhere and on anything. There are no limitations on the number of learners that a teacher can work with using RedHalo, neither is there a limitation on the number of learners that a single learner can collaborate with.

RedHalo embraces the power of the Internet and allows learners to be completely mobile with their digital learning experience. A learner can access their space using a laptop computer at school, their phone on the way home, a PSP in their bedroom or show their work to their parents via the Nintendo Wii in the living room. All of their work is stored, archived and retrievable. Teachers can review work and distribute learning materials at anytime and wherever the learners may be. Third party software developers can create plug-ins for RedHalo using publicly published programming interfaces. This is what RedHalo means by “Learning while mobile”
RedActivity is an integral application within RedHalo that provides a complete environment where learners can build a complete multimedia Activity using the set of tools on their mobile device. For example, they can combine and show the relationships between numerous content elements such as web pages, written documents, videos, audio recordings, drawings, photos and spreadsheets then hand it in as a single Activity. The Activity along with its associated media components is automatically sent to the RedHalo server for educator review. This is where things get really clever. RedActivity builds and presents the activity as a simple to navigate website for the educator or reviewer to assess. Each component of the Activity can be selected for review. Tight integration with the RedHalo synchronization platform means nothing gets lost so it’s clear what media components belong to which Activity. RedActivity folders can easily be tagged for transfer to 3rd party e-portfolio or assessment systems.

ConnectED

ConnectED enhances educational outcomes through technology, delivering ‘learning without barriers’. ConnectED represents, markets and sells Sony Playstation, Sony Virtuoso, Lecturnity Lesson Capture and M-Link Linux based laptops in UK Education. ConnectED also provides information, support and multimedia teacher training to make sure that learning outcomes can be effectively delivered.

PlayStation Portable (PSP) provides great levels of accessibility through its wireless browser to deliver Podcasting, Virtual Learning Environments and video, combined with a price point which is significantly lower than any other handheld device. The new digital camera peripheral now allows self authoring of video and audio as well as video conferencing from one PSP to another or one PSP to a PS3. Supported by British Telecom’s new 21st Century Network platform this adds a significant educational value to PSP’s product set.

‘A serious and growing skills gap, between students whose knowledge and use of multimedia expands by the day and teachers throughout education, who do not understand or use multimedia formats to enhance educational outcomes’. Many students are now using multimedia formats outside the classroom as the rapid growth in the social networking sites of BEBO, YOU TUBE, FACEBOOK and MYSPACE demonstrate.

5. 1000 British delegates are expected at the Handheld Learning conference to be held in London in October 2008. If each of these delegates has been involved in the provision of mobile learning in some way, then mobile learning in the UK is thriving indeed.

II

Level 2 consists of countries in which there has been mobile learning activity mainly in the form of participation in European Commission funded projects. These countries are: Austria, Bulgaria (notably the University of Plovdiv), Cyprus, Czech Republic, Denmark, Finland, Hungary (notably Corvinus
The mobile learning activities represented by this grouping of countries include:

- participation in European Commission funded mobile learning projects
- participation in mobile learning projects funded by other funding agencies
- presentation of papers on mobile learning at international conferences, both specifically on mobile learning and on other aspects of the use of technology in education
- contribution of articles on mobile learning to international journals, both specifically on mobile learning and on other aspects of the use of technology in education
- representation on the Editorial Board of mobile learning journals.

**AUSTRIA**

*Mobile Game Based Learning (mGBL) (2005)*

The project was established on October 1st 2005 by five countries (Great Britain, Italy, Croatia, Austria and Slovenia) and funded for three years by the European Community through the 6th Framework Programme. The project main aim is to use the mobile phone to implement games bridging the real and the virtual world. The project idea is based on the fact that today mobile devices are getting more and more diffused. Particular mobile phones can represent what young adults, with different levels of education and culture, have in common. The target audience is younger people aged 16-24, people with high interest in mobile technologies and in lifelong learning, and their teachers. A special focus is given on the implementation of mechanisms known from marketing and psychology to trigger an emotional learning process.

*The Collage (2006)*

The Collage project started on January 1st 2006 and it will be completed by January 1st 2008. It is supported by the eLearning initiative of the European Commission. The Collage Consortium includes 9 organisations from 6 countries (Austria, Denmark, Greece, Spain, Sweden, United Kingdom).

This mobile learning application tries to push the advantage that students (12 – 16 years old) really like to use their mobile phones, laptops and PDAs. This project brings to secondary school students and their teachers a mobile learning platform for context-dependent games, which eventuates in fun, interdisciplinary work, collaboration and challenges beyond the four walls and it creates new learning opportunities. The game uses mobile learning technology (especially mobile phones, PDAs and GPS technology), therefore users can communicate with other players directly. The main aim is to use
existing experiences in the field of mobile learning, and integrate them in an innovative mobile learning support and information application.

**ESMOS (2005)**
This two-year project started in January 2005 funded by the Socrates Programme/Minerva Action. It included six universities from the UK, Italy, Austria, Lithuania, Poland and Bulgaria.

The aim of the ESMOS project was to improve and enhance the quality of student's mobility experiences by providing them with a high level online support. A new methodology has been developed for international mobility student support, using a variety of technologies and online tools, such as blogs, SMS, MMS and virtual classroom applications along with the traditional virtual learning environment. The methodology has been elaborated to become a model for the virtual support of mobility students.

**BULGARIA**

*University of Plovdiv*

M-Campus’s subsystem “Queries for candidate students” offers m-services for the candidate students of the University of Plovdiv. Using it and his/her mobile phone, any candidate student can access the http address of the system’s Web page (http://bell.pu.acad.bg/KSK2/Default.aspx) and check the dates of the candidate students exams and other actual information about them (for example if the exam results are published and what is his/her grade for a specific exam). A query facility about the result standings is in the process of development.

The new UMTS (3G) technology offered by Mtel allows users to share video and voice with better quality and with higher speed. This offered the possibility to develop a new version of the Learning Management System DIPSEIL – Mobile DIPSEIL. This version consists of two parts – mobile (which is installed on the phone) and teacher side (which is on our web-server). This allows students to connect to and to study courses via their mobile phones.

**CYPRUS**

CARDET – The Center for the Advancement of Research and Development in Educational Technology lists some mLearning initiatives in Cyprus. CARDET is a non-profit research and development organization (NGO) based in Cyprus with partners around the world. CARDET’s mission is to inspire next generation education, and to promote research, innovation and development through evidence-based practices, cutting-edge research, and empowered people. There are two main mlearning projects in Cyprus; Handlearn and Technoskepsi, both developed with funds of the Cyprus Research Promotion Foundation.
Handlearn (2006)

The aim of this project is to investigate the use of handheld technologies within informal science learning settings as a means to support inquiry-based science learning. More specifically, the project aims to: (a) develop research-based instructional material based on sociocultural theories of learning, informed by perspectives on the nature of science issues and the use of technology to support learning; (b) to investigate the role of handheld devices in teaching and learning in science and (c) to produce material for teacher professional development.

Technoskepsi (2006)

The aim of Technoskepsi is to investigate the ways in which handhelds can support argumentation in science. More specifically, the project aims to: (a) develop a learning environment that makes use of handhelds and aims to help young students to develop arguments; (b) investigate those features of the handhelds that might support students while they construct arguments and; (c) create case studies of students working with technology and argumentation to be used as part of teacher professional development in science. The learning environment will be developed based on project based learning, sociocultural theories of learning, and what we already know regarding how young students construct arguments.

CZECH REPUBLIC

eMapps (2005)

eMapps is a project of “Motivating Active Participation of Primary Schoolchildren in Digital Online Technologies for Creative Opportunities through Multimedia” and is operated within the 6th Framework Programme. The target audience of the project are children of the ages between 9 and 12. The aim of the project is to build communities of creative, networking children in the new member states, generating their own cultural content and communicating with peer groups in other countries and to develop adaptable interactive tools (primarily games played on a mobile platform) with which to deliver learning objectives and which help to integrate the use of ICT into education. The game is played in 10 countries: Czech Republic, Great Britain, Spain, Slovakia, Slovenia, Hungary, Poland, Estonia, Latvia and Lithuania.

Transmobile (2003)

Transmobile is a pilot project for the integration of mobile learning into vocational education. The project is supported by the EU Leonardo Da Vinci II. Action Programme and it consists of 10 European partners, including: Austria, Czech Republic and Slovakia. The project main aims are the following:

- design learner-centered teaching for mobile devices (mobile phones, PDAs, laptops)
- the development of a certification concept for the retail trade
**ULRYCH Mobile-Learning**

Ulrych mobile-learning is a product of one of the biggest language schools in the Czech Republic: the ULRYCH Language Studio. The users can choose the most fitting service for themselves:

- it can be used as a supplement to the ULRYCH University e-learning study
- as a separate language course,
- or boost your communication skills and confidence in a specific field or topic.

The students can reach the mobile-learning services by calling numbers using both mobile and fixed telephone lines.

**DENMARK**

**ARKcast**

Museums and science centres apply mobile units for games and pod-casting. Arken Museum for Modern Art ([www.arken.dk](http://www.arken.dk)) provides podcasts about new exhibitions. ARKcast is a guide that presents current exhibitions through interviews and features with artists, experts and collectors. Visitors may borrow Ipods in the museum shop. The podcasts can also be watched or listened to online or be downloaded to a computer and transferred to an MP3 player.

**Healthcare in the Aabenraa Municipality**

Forty health care workers in the Aabenraa Municipality have been provided with mobile phones to subscribe to relevant mobile learning content. The learning material includes text, graphics, sound and video files that are provided as podcasts. The content presents ethical dilemmas that prepare the health workers for situations they may encounter in their work. For each dilemma, one may choose from several answers that are used to present more or less appropriate conduct. The material is especially developed for learners with limited reading abilities or knowledge of the Danish language.

**Hip Hop language course**

The Danish Broadcasting Corporation (DR-Undervisning) used PDAs, iPods and mobile phones in the language course “Hip Hop” in which the target group was students in upper-secondary school who didn’t have Danish as their mother tongue. Students in the target group could borrow PDAs for the one week duration of the course. According to Mosbech (2007), both the hip hop related content and the mobile learning approach was chosen to increase the target group’s attention and motivation.

**Flex-learn**

Flex-learn ([www.flexlearn.dk](http://www.flexlearn.dk)) has developed several video based programs that are available via a learning management system for PCs and also via a
learning management system for mobile equipment. One example is a video project about transport of hazardous goods which found that the mobile technology had a potential for motivating people with low reading skills.

Energy efficient driving
Vitus Bering Danmark received the international Boldic Award for its mobile e-learning course on energy efficient driving for trucks and busses. The course includes 22 study units that are especially developed for mobile phones.

Procedures for train departures
Employees at the Danish railroads (DSB) use their PDAs to check ticket prices and work plans. In addition they may learn the procedures for train departures via a video on their PDAs.

Melfo (2006)
The Melfo-project aims at providing a facility for mobile e-learning to people with reading difficulties. Experiments will be carried out at an entrepreneur enterprise, Davidsen Partner. Here, mobile e-learning can give people with reading difficulties assistance in everyday-life using the new technologies, making it easier to read technical manuals and to understand project drawings and technical translations, to mention a few examples.

E-learning for farmers via podcasting and online radio
Knowledge Lab is conducting a project with the developing mobile learning for the agricultural sector together with Courseware and Danish Agricultural Advisory Service. The project is aiming at elucidating the potential of and interest in mobile learning in the agricultural sector.

eBag – the digital school bag (2004)
The eBag is a personal, digital repository in which students can place pictures, video, music, text documents and other digital material for use in and outside of school. Several students can share material in a common project repository. According to an article published in English (Brodersen et al), the eBag serves as a link between different types of displays, through which its contents can be accessed, and allows the pupils to collect, carry, access, and share digital information very easily. The resources can easily be presented on PC at home and school as well as on large wall displays. The students' mobile phones automatically identify the students and provide access to, and share resources with, other devices via Bluetooth signals. The phones are also used to upload pictures and audio recordings from the mobile phones to the eBag repository.

FINLAND

University of Tampere

A number of mobile projects have been carried out at the University of Tampere related to use of mobile phones and learning. The ‘Mobile and
Internet Trends 2004’ was carried out by the Hypermedia Laboratory at the University of Tampere. Among the research questions was the question on which formal and informal learning strategies young people and seniors acquired when using mobile phones and other ICT.

The LIVE Project (1997)
A very early application of mobile learning in Finland was the LIVE (Learning in Virtual Environments) Project which was carried out by the Educational Centre for ICT at the University of Helsinki. Already from the start in 1997 the project tried out mobile communication technology to test real-time interaction between the schools and the surrounding reality in learning situations. Nokia 9000 Communicator was used because of its functionalities as personal organiser, phone, fax, address book, e-mail and Internet connection.

The UniWap Project (2000)
The UniWap project set up by the Educational Centre for ICT at the University of Helsinki was also one early mobile learning project carried out in Finland. The aim of the project was to develop educational use of mobile technology and to find out pedagogical applications beneficial to students and faculty in the virtual university. The project dealt with testing of WAP technology in order to facilitate teaching and learning.

Mobile Learning in Home Economics Teacher Training and Forest resource Management (2002)
The idea of carrying a pilot on the use of mobile learning in home economics teacher training was that supervising teachers and trainee students should discuss and share their ideas about teaching methods and other topics through mobile devices. The trial was carried out among students in real life and in study situations. 11 students and 5 teachers participated in the project. Nokia 9210 mobile phones and digital cameras were used in the project. The project used SMS-messaging and digital pictures as part of the supervision process. The use of digital pictures, which were delivered via the mobile device, was according to the researchers in the project very successful.

The trial at the Department of Forest Resource Management included 14 students and 3 teachers. There were two groups of students, one out in the forest and one in the university computer room. The group in the forest took pictures and sent them with GPS coordinates for analysis in the database. Thus, mobile technology was used to deliver textual and pictorial material from forests.

MobileED at the University of Art and Design – Helsinki (2006)
The MobileED project aims to design learning environments that are meaningfully enhanced with mobile technologies and services. This includes the design of scenarios and guidelines of how mobile technologies could be used for teaching, learning and empowerment of students within and outside the school context, and also concepts, prototypes and platforms that will facilitate and support the scenarios and guidelines developed. The project also tests, evaluates and disseminates the scenarios, guidelines, concepts, prototypes and platforms. The main partner is Meraka Institute of South Africa.
Moop – Mobile Learning Environment as part of daily school work (2005)

The project is conducted by the Department of Education in the city of Oulu in cooperation with a software firm, Incode Oy, which has developed the Moop environment. Three elementary schools have participated, the schools of Korvensuora, Oulunlahti and Patamäki. The project has received funding from Oulu’s development project for network services and from the Smart Oulu project (Mattila 2005, Mattila undated, Mattila & Fordell 2005).

HUNGARY

AITMES (2005)

Training through real scenarios with teachers. Seeing how these scenarios work out in practice under several networks outside and indoor and extract conclusions for a Handbook. Enhancing the competence of Teachers using mobile devices to create, search and modify networked information resources and share it on real time over mobile networks such as GPRS, 3G, WIFI. Discuss the learning consequences of the different strategies for training purposes.

Cityguide (2005)

This project was running between February 2005 and October 2006. The project’s main aim was to develop a platform which helps the tourist in another country to „feel at home”. Before the journey the traveler can plan the route and decide the sights what they want to see. But that is not all, with the help of a mobile device (smartphone, PDA) the tourist can discover the city alone without being lost. The project’s result is a polyglot (Hungarian, English and German) platform, which keeps the information about many cities in its database. Text, voice and video information can also be stored there.

CONTSENS (2008)

The profile of the typical mobile device is changing rapidly. As a result it is now possible to envisage an audience for mobile learning content which is media rich, collaborative and always available to the user. Using established technologies such as GPS and SCORM, and developing for newer technologies such as RFID (Radio Frequency Identification) and Mobile Positioning, training content will be developed for both context sensitive and location based delivery. The operational and specific objectives addressed by this recently started project (Hungarian partner: Corvinno Technology Transfer Centre) are the development of innovative ICT-based content, services, pedagogies and practice.
**LOGOS (2006)**

Logos is an IST research project involving an interdisciplinary 15-member consortium from nine countries (including Hungary), coordinated by the Hungarian broadcasting company Antenna Hungaria. It was established in 2006 for three years with a budget of more than 3.6 million Euros. The project’s aim is to make a digital database available by various devices and integrate:

- Internet based communication
- 3G mobile devices
- Digital video broadcasting.

The project has four Hungarian institutes:

- Antenna Hungaria
- Eduweb Multimedia
- Budapest University of Technology and Economics
- IT Ware Ltd.

**MOBILE INNOVATION CENTRE (MIK) (2005)**

The MIK was founded as a result of the call for proposals “The Establishment of R&D and Innovation Centre for Mobile Communication” supported by the National Office for Research and Technology. The Centre is based on the cooperation of universities, an academic research institution, industrial companies, suppliers and organisations dealing with scientific research and
innovation, including the representatives of profit-oriented and non-profit sectors.

Similar technological centres can only be found in a few advanced countries. The MIK is a consortial partnership founded by 17 consortial partners. The Mobile Innovation Centre was established to solve the scientific and technological questions which contribute to the clearing up of the problems existing in future mobile and wireless systems, to the implementation of 3G services and to the introduction of later mobile and wireless communication technologies and to the development of the up-to-date applications on the systems. Furthermore, its aim is to draw in small and medium sized enterprises into the above–mentioned topics.

Mobile Learning in Mainstream Education
This is a European Leonardo da Vinci Project with the MTA ITA (IT Foundation of the Hungarian Academy of Science) as a partner. Mobile learning is the provision of education and training on mobile devices (PDAs, smartphones and mobile phones). The future is wireless. All over the world wired technologies are giving way to wireless technologies. For mobile learning to enter into mainstream education and training the following are necessary:

- Guides for the development of mobile learning need to be produced for mainstream institutions
- SMS (text messaging) needs to be established as a standard administrative structure in education and training institutions.
- Short courses, course summaries, examination preparation need to be developed for mobile devices
- Full modules need to be developed for mobile devices
- Mobile learning modules need to be offered to fee-paying students with full evaluation, normal awards and accreditation

Mobile Learning: the next generation of learning
This is a European Leonardo da Vinci Project, with the Department of Information Systems, Corvinus University of Budapest as a partner. This department is very active in introducing mobile learning in mainstream education. The first developments have started five years ago and since then the department participates continuously in European research consortiums, dealing with various segments of mobile learning. At the moment the staff of the department are working on the following mobile learning fields:

- Adaptive knowledge and skill assessment using mobile devices
- Content development for PDAs, Smartphones and mobile phones.
- Continuous development of our mobileLMS (CooSpace)
- Support of administration in the higher education using mobile devices.

The role of mobile learning in European education
The objective of this project is to bring the unprecedented ownership of mobile devices into European education and training. For this reason the first target group is Commission decision makers and decision makers in the 25 EU states to whom the products of the project will be personally sent. Further target groups are the students and institutions in the partner countries, and eventually in the whole 25 countries. The problem is that students use their mobile phones constantly but not yet in their education. The main activities - carried out by Corvinno Technology Transfer Centre in Hungary - which will result in the products of the project, are: development of a policy document on the role of mobile learning, an overview of the role of mobile learning in the 25 states today, listing of achievements of mobile learning, pedagogical aspects of mobile learning, adapting ILT and e-learning materials to mobile learning, the development, adaptation, teaching and evaluation of mobile learning courseware for real students.

IRELAND

*Ericsson Education Ireland*

Ericsson Education Ireland began work in the field of mobile learning in 1999.

In early 2000 a first project, *From e-learning to m-learning*, was submitted for funding to the European Commission, it was approved in mid-2000 and work began on 1 October 2000. This funding allowed EEI to research and develop thinking and courseware for mobile devices based on the devices and technology available. The outputs of each of the projects has to a large extent followed the progress in the development of devices and networks. During this first project, courseware was developed very successfully for PDAs.

A second project was undertaken from 2003-2005 with the title *Mobile learning: the next generation of learning*. The introduction of the Opera Browser and Flashlite facilitated the development of visually attractive courseware for Smartphones in this second project and gave a glimpse of how J2ME could be used to do similar for the "ordinary" mobile phone. This project has been nominated for an EU projects quality award. Ericsson was complimented on its commitment to share the research.

A third project was undertaken from 2005-2007 with the title *The incorporation of mobile learning into mainstream education and training*. Networks, download speeds, screen size, application development and device memory are all converging to enable mobile learning enter mainstream education which is the theme of this project. Ericsson Education has purchased a new Learning Content Management System (LCMS). As part of the project, templates were developed to enable the deployment of mobile courseware to a number of different mobile devices.

A fourth project in the Socrates programme with the title *The role of mobile learning in European education* is still in progress in mid-2008. It is evident from attending international conferences on mobile learning that there is quite
a lot of research going on in different institutions. Ericsson has been to the forefront of that research and the challenge now is to mainstream it. With 100% penetration for mobile phones in most European countries, the roll out of 3G and HSDPA, the development of more sophisticated devices, the time has come for education to be included as a revenue stream.

Ericsson Education Ireland has just embarked (late 2007) on a project under the European Life Long Learning program, with the title *Using wireless technologies for context sensitive education and training (2008)*. This project will focus on the development of appropriate training/learning materials for mobile learning enhanced by context sensitive and location based delivery.

**ITALY**

**CRMPA, CENTRO DI RICERCA IN MATEMATICA PURA ED APPLICATA, UNIVERSITÀ DEGLI STUDI DI SALERNO**

The spread of the use 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 these new categories of users. Never as before the learning may become “when you want” but also, and this is the potential of mobile technologies, “where you want”, in the street, in the metro, when it is necessary or when there is enough time. Moreover, mobile technologies allow to provide continuously training to those users that are not taking part in the traditional education, but have a mobile phone and use it every day.

The mobile users community is a complex and variegated world characterized by different devices and technologies, continuously changing. Technologies span from highly diffused SMS (Short Message Service) to MMS (Multimedia Messaging Services), from WAP (Wireless Application Protocol) to HTTP (Hyper Text Transfer Protocol) and from GSM (Global System for Mobile Communication) to GPRS (General Packet Radio Services) to UMTS (Universal Mobile Telecommunications System). Devices vary from mobile phones to PDAs, from last generation Smart Phones to Laptop computers. Our aim is to extend an existing e-Learning platform, IWT (Intelligent Web Teacher), in order to allow the design and delivery of significant learning experience among a huge set of mobile technologies. This was done in the context of an EC funded project named m-Learning ([www.m-learning.org](http://www.m-learning.org))

*Giunti Labs S.R.L.*

Giunyi Labs S.r.l. is a Company of the Giunti Publishing Group in charge of designing and developing new services and solutions for technology based learning, content management and new media. More specifically, the R&D Department focuses on the following topics:
• design and development of software architectures for advanced XML-based content/knowledge management. Management of XML native databases
• user-dependent application and content profiling (personalization)
• design and development of web-services based portals
• wireless/mobile services for supporting on site industrial maintenance
• context-aware, location-based, mobile content management and delivery services
• innovative applications for the exploitation of RFID technology in several fields (tourist support in museums, industrial and commercial applications, etc.)

With respect to the research and development of innovative mobile learning and training applications, GIUNTI Labs has been involved in two major projects at European level: MOBIlearn and WearIT@Work.

The 33-months MOBIlearn project, which is presumably one of the World's largest R&D initiative dedicated to the set up and study of mobile learning trials (8 MEuro of total costs partially funded by the EU), came to end with measurable results and outcomes. Partners such as Open University UK, University of Birmingham, HP, Emblaze, Nokia, Space Hellas, Deutsche Telekom, Telecom Italia and many others, have come together under the coordination of GIUNTI Labs to define an abstract framework for educational-oriented mobile services development and deployment (the OMAF, Open Mobile Abstract Framework), to be easily layered on top of existing e-learning frameworks (e.g. the eLearning Framework of JISC for the UK Higher Education or the OKI, Open Knowledge Initiative, designed by MIT for the US) to unleash the power of mobile services (e.g. location based, context awareness and mobile communities) for the mobile student and employee.

Within MOBIlearn a web services-based implementation of the OMAF was deployed and three different test bed scenarios for MBA, Medical and Art education where set up respectively by University of Zurich, Open University UK and GIUNTI Labs. The outcomes of the MOBIlearn project, both in methodological and technological terms, gave GIUNTI Labs the opportunity of extending its existing Learn eXact® commercial e-learning platform with features and plug-ins suitable to support enhanced mobile learning experiences (eXact Mobile).

The main objectives of the WearIT@Work project, a 54-months EU integrated project with 14MEuros funding, are the design and development of solutions based on wearable computing technology for professionals in industrial production, maintenance, hospitals and emergency services. WearIT@Work aims at proving the applicability of computer systems integrated to clothes, the so-called wearables, in various industrial environments. One of the key application scenarios considered in the WearIT@Work project focuses on the support of maintenance activities and empowerment of professionals in the

**NETHERLANDS**

_Educause_
The Educause Center for Applied Research (ECAR) produces research to promote effective decisions regarding the selection, development, deployment, management, socialization, and use of information technologies in higher education. This case studies the educational applications of mobile technology in The Netherlands: ‘Using Mobile Technology to Enhance Students’ Educational Experiences’ (2005). They conclude that: “their experience so far has demonstrated that digitizing and publishing existing materials on the Web may have limited influence on educational materials’ quality and effectiveness if it’s not linked to a redesign of the course itself. The mobility dimension changes the relevance of the educational materials’ various parts; students' attention span; the focus of their education effort; and their attitude balance toward reading, experimenting, interacting, and communicating. But mobile tools also offer new communication opportunities that students have already adopted”.

**Manolo project (2006)**

This project is sponsored by the SURF Foundation. In this project mobile learning was used in several case studies.

- **Case Wageningen University and Research (WUR) – GIS and remote sensing.** A school for secondary education was searching for challenging activities for talented pupils. The students worked in groups with PDA’s with GPS. They used those devices to solve the case (to create a PDA-guided trip for talented pupils). In addition every group used a tablet-PC connected to the wireless network of the university. They used the tablet-PC for groupwork (wireless office), brainstorming, meetings and communication.

- **Case Wageningen University and Research – environmental studies.** Students examined the influence of tourism on the moor. Tourist walked on the moor with a GPS-receiver. That way students could register where they walked. Afterwards the tourists were interviewed and the interview data was entered on PDA or tablet-PC.

- **Case VU University Amsterdam – Archeology.** During archeological fieldwork in the South of Italy, the remains of old Greek cities were charted. This data was entered in PDA and could be analysed that instant. Results of the project: It takes time to learn how to use PDA; mobile technology should be used systematically in different lessons; students should work in authentic settings; make it possible for students to share their enthusiasm for mobile technology with others.

**NORWAY**
There are a number of examples of projects on mobile learning in Norway. Projects may have been initiated by industry with needs for flexible on the job training, universities, school authorities and distance teaching institutions. ITU (Research and Competence Network for Information Technology in Education) is a centre responsible for stimulating the development of ICT applications in schools and teacher education. It is administered by the University of Oslo and funded by the Ministry of Education (Kunnskapsdepartementet). Its research series edition no 9 2007 concerned the use of handheld technologies in education “Pedagogical praxis with handheld technologies”).

ITU (ibid.) argues that young peoples’ activities are characterized by extensive and varied use of technology and those handheld units, such as mobile phones, PDAs, video cameras and mp3 players, are especially popular. The use of handheld units allow access to learning activities independent of time and place, and thus gives possibilities for extending traditional arenas for learning, to move learning outside classrooms and that what, when and where we learn will change drastically. According to ITU it is assumed that handheld applications make it easier to use ICT outside the classroom, support student ownership of the learning processes, promote motivation, support individualized learning, increase student interaction face-to-face and stimulate technology supported cooperative learning (Ibid.).

Mobile learning in schools

Wireless pupils at Åmot junior high school (2003). PDAs were used in learning activities for 9th grade pupils during 2003. The project was supported by ITU. It was in a way a large scale projects where all pupils and teachers were equipped with PocketPC/PDAs. The devices had built-in WLAN card and Bluetooth facilities (for short distance communication). According to the school’s own presentation it was the first large scale project of this kind world wide. When the project was completed in autumn 2003 it was concluded that the handheld technology was too little developed to function satisfactorily for pupils’ reflection on personal learning.

Mobile learning in business and industry

Statoil mobile learning project 2006-2007. In 2006 Statoil invited several suppliers of teaching-learning solutions to tender for developing mobile learning solutions for in-service training for employees in Norway and Denmark. The Statoil project “Læring på farten” (“Learning on the go”) is a pilot project on the use of mobile terminals for in-service training.

The main aim of the project, which is ongoing (December 2007) is to try out and gain experiences with new learning methods. Content and communication solutions are adapted for user friendly navigation and reading on PDA screens.
The pilot on mobile learning is supposed to give Statoil

- Experience with strengths and weaknesses involved in mobile learning
- Basis for taking decisions on which contexts are suitable for mobile learning
- Internal competence in demands and requirements for developing and administering mobile learning

Mobile learning at university and college level

The Multi Media Centre of the Norwegian University of Science and Technology has conducted a couple of projects on mobile learning.

The autumn 2005 project on mobile learning was established because of an experience of new demands from students, that new technologies were available including more advanced mobile terminals and new networks and a local project ‘wireless Trondheim’. The main aim of the project was to make lectures universally available independent of time and place and type of terminal.

The second mobile learning project at NTNU was carried out in 2006 and built on the experiences from the first project. This project included the adaptation of the LMS used at NTNU, ‘It’s Learning’, to mobile users. Also in this project (in the university tradition) introductory video lessons were applied. Both the videos and the total LMS application was tested for usability. It was found that increased quality of the technology made the solutions better, and not least that mobile applications integrated with the standard LMS were natural developments of the teaching-learning solutions.

Mobile learning in distance education

Mobile Distance Learning at NKI Distance Education. NKI has during the last 6-7 years developed mobile learning services as an integrated service of online distance education. The developments have been part of research and development activities related to a number of EU supported Leonardo da Vinci projects. The main projects were: From e-learning to m-learning (2000-2003), Mobile learning- the next generation of learning (2003-2005) and Incorporating mobile learning into mainstream education (2005-2007).

When developing system solutions for mobile learning, it is assumed that the NKI students normally will have access to a desktop or laptop computer with Internet connection. This means that the equipment and technologies used when mobile are additions to the students’ equipment used when studying at home or at work. It is also assumed that mobile learners study in the same group as students not having access to mobile technology. Thus, the learning environment of NKI is designed to cater efficiently for both situations and both types of students.

PORTUGAL
Minho University

Portugal is slowly waking up to mobile learning. The institutional repository of Minho University has already some papers related to mobile learning. One named “M-learning and webquests: the new technologies as pedagogical resource” was written by João Batista Bottentuit Junior (jbbj@terra.com.br) and Dulcerci Sternadt Alexandre (sternadt@hotmail.com) from Porto University and Clara Pereira Coutinho (ccoutinho@iep.uminho.pt) from Minho University. This paper has as its main goal to bring to discussion new educative ways of using information and communication technologies, specifically the use of m-learning to access a webquest. They developed a webquest entitled “Learning with Plants” to be used in the Sciences classes in the 5th grade. The mobile devices allow students to access the webquest from the real world, joining theory to practice.

LinguaNet (2006)

The project LinguaNet has some Portuguese partners Ana Leal and Miguel Barbot from the SPI. SPI is a company dedicated to offering its clients the most effective consulting through a variety of services that assist clients in promoting innovative thinking and international opportunities. Through effectively applying current practices that encourage and manage innovation, SPI is well positioned to act in the most diverse geographic regions, meeting the needs of its clients in the business areas of Consulting, Training and Research & Development. SPI has established a strategic presence in Europe, North America and Asia which together with the company’s global network of experts provides clients with the necessary support to meet their international business and professional needs.

SLOVAKIA

There have been Slovakian partners in the following European Commission mobile learning projects: eMAPPS, LOGOS, Transmobile, HUBUSKA. Presentations of these projects are provided in other parts of this report.

SLOVENIA

There have been Slovenian partners in the following European Commission mobile learning projects: eMAPPS, Mobile Game Based Learning (mGBL), UNITE, AITMES. Presentations of these projects are provided in other parts of this report.

SPAIN

The Mobile Technologies for Mobile Learning (MoTFAL) Project (2003)

The MoTFAL project is a joint initiative of pedagogical, cognitive science and technological experts, educators, and psychologists to research the possibilities of using mobile platforms with Internet access for educational
purposes at school level. It involved collaboration between schools in Greece and Spain. The students from Spain would take digital camera enabled PDAs (in the future this will include video) into archaeological sites in Spain. The students in their classroom in Greece would text requests for information and photos to the Spanish students who would then comply and respond. The students would also describe distances and send photos with students in front of artefacts to provide an idea of size. This process would then be completed in reverse.

*CAMPUS (2006) - Generalitat de Catalunya*

The CAMPUS project was promoted by the *Secretaría de Telecomunicacions y Societat de la Informació* (STSI) of the *Generalitat de Catalunya*, born from the decision of eight Catalan universities to have a virtual campus in free software and under the license of GPL (General Public License). This campus should allow offering higher education both in a completely online fashion and combining online and offline. One module of this campus will be access to the virtual campus features for handheld devices (any with internet connectivity, such as PDAs and 2nd+ generation cellphones) and TVs with Internet connection (IPTV, etc). Another module will be about podcasting, bringing tools both to teachers and students.

*Europodians*

Javier E. Díaz Vera coordinates the Europodians project in partnership with other 10 different institutions from the EU. It intends to provide an opportunity to use mobile communication devices as phones, iPods and PDAs during language courses in universities. 12 European countries participate in the project, which is funded within the framework of EU Socrates program. Course material of Europodians will be interactive and made for learning with the help of various mobile communication devices. The materials will be available in the Internet. Wide range users are the target audience of the course. Mobility is the main benefit of Europodian project – the course can be used, for example, during a journey.

*Telefónica (Movistar) (2004)*

Two companies belonging to the Telefonica group, Cynet and Educaterra, developed a m-learning platform to be used by the employees of Telefonica’s mobile operator, Movistar. A total of sixteen courses were created, with two versions available, one for mobilephones and another one for PDAs or laptops. After the success of the experience with the then 4.700 employees of Movistar, Telefonica decided to extend the project to the rest of the Telefonica’s employees in 2006.

**SWEDEN**

Sweden is generally an advanced country in the use of technologies. Mobile phone use is no exception. From the early start of mobile technology development, Sweden was in the forefront. At the end of 2006 Sweden had 9.6 million mobile subscriptions, among a population of 9.06 million. The
average mobile phone subscriber in Sweden talks 1.8 hours per month and sends 25 messages.

Research on mobile learning at Växjö University
The School of Mathematics and Systems Engineering at Växjö University has a research group that has been involved in a number of theoretical and practical research projects on the use of mobile phones and handheld computers in learning. The 'Center for Learning and Knowledge Technologies' at Växjö University describes its activities as follows: "Our current research interests include two main topics; the development of mobile and wireless applications to support collaborative learning and the design of interactive learning environments to support collaborative discovery learning about complex domains".

Collage (2006)
Collage is a European project led by Växjö University. It is supported by the eLearning initiative of the European Commission. The aim of the Collage project is to develop and test a mobile learning platform context dependent games for secondary school teachers and students. The platform developed supports the authoring and playing of a board-like game on a site of educational interest. The games are played with the aid of mobile learning technology (mainly mobile phones and PDA's, and GPS technology) with direct communication with players situated on site or in the classroom.

CONNECT (2004)
The Connect project is also led from the CeLeKT group of Växjö University. The CONNECT project sought to create a learning environment that will wed effective informal learning strategies with exemplary formal curricular activities in an attractive learning environment that utilizes cutting edge information and communication technologies in science education, AR (Augmented Reality) and specific mobile technologies.

Illustration from the CONNECT project site

The aim of the project was to explore, test, refine and demonstrate an innovative approach that crosscuts the boundaries between schools, museums, research centres and science centres and involved students and
teachers in extended episodes of playful learning. Specifically and practically the project sought to map the evolution from the wired virtual learning environment of today, to the wireless learning environment of tomorrow. The project was supported by the EU Commission’s Sixth framework Programme and involved a large group of partners in education and technology from many countries, Greece, Germany, Israel, USA, UK, Belgium, Spain, Denmark, Portugal and Finland. http://www.ea.gr/ep/connect/main.asp?Cat_ID=380

**AMULETS (Advanced Mobile and Ubiquitous Learning Environment for Teachers and Students) (2006)**

The AMULETS Project is a Swedish project led by CeLeKT in collaboration with the Teaching Training Program at Växjö University and local schools in the Växjö region. The AMULETS project is exploring how teachers can develop and implement novel educational scenarios combining outdoors and indoors activities that use ubiquitous computing and mobile technologies together with stationary computers. Since June 2006, more than one hundred elementary school children and eighteen teacher students from Växjö University have performed outdoor activities equipped with smartphones, PDAs and GPS devices in the field of natural sciences, history, geography and sports.

**Wireless Handhelds in Mobile Learning (2002)**

The project was carried out at the Informatics Department at Umeå University. According to the project information pages, the main aim of the project was to study student's communication patterns using mobile devices and what implications this use may have on the design of learning environments. The project designed a learning environment based on mobile services and applications and conducted several experiments with student groups using a PDA connected to a network (GSM or GPRS). The results of the experiments were to create a base for future guidelines for evaluation and design of mobile learning environments.

III

Level 3 countries are making their first steps in the field of mobile learning. These countries are: Estonia, France, Greece, Latvia, Lithuania, Malta and Poland.

**ESTONIA**

Interesting school/home links can be found in Estonian schools (mainly in Tartu and Tallinn) where teachers communicate via an internet platform or mobile phones. In the *e-diary* project, which is a private initiative, parents can see information about their children's homework and achievements. The *M-Teacher project* (2005) in the city of Tartu allows teachers to send announcements to parents via mobile phones using a special web page. M-teacher was one of the most successful m-Tartu pilot projects and is being
implemented in the whole Tartu city. In summer 2005, the feedback analysis of the project was conducted. In the following pages, the results of m-Tartu pilot are presented.

FRANCE

Halifax

Halifax is a privately owned company based in Paris and Madrid, set up in 2003. The services proposed are focused on sales and management training for medium sized companies and large accounts: open courses (15% of turn over), in house training (72% of turn over) and distance learning (13% of turn over mainly elearning devices, web learning and since end of 2007 mobile learning).

The company has decided to launch a very innovative service of mobile learning adapted to sales forces and the needs of their employees faced to a complexification of sales training (fierce competition, increase of turn over expected with the papy boom, increase of number and rotation of products and services to sell, implementation of technological processes CRM and SFA). The sales people in the companies are a nomad population with many useless time periods in their activity and most of them are young people under 30, bred with the use of the mobile phone). The development of data connections and smartphones opens new ranges of opportunities for mobile learning in short sequences of 2 to 5 minutes to:

- measure the knowledge of products and processes
- repetition to anchor key messages of the sales processes
- get instantaneous information to help sales closing
- train to selling skills after a course
- have information reports coming from the field

Halifax has developed a specific platform with a wap service which can deliver messages in a push mode (sms, mms, video) or pull mode through the wap service. It enables the organization of quizzes, tests, votes with an immediate report of answers but also communication to sales force for incentives or animation.

GREECE

The Ad-Hoc.com project

The Ad-Hoc.com project (2001) – Ellinogermaniki Agogi School language learning independent of time and location developing real life scenarios (e.g. visit to a museum, at a bank etc.) focusing on PDAs’ multimedia capabilities and short-range wireless communications technologies using tools like Embedded Visual Basic 3.0 and Embedded Visual C++ testing applications
The Mobile Technologies for Mobile Learning (MoTFAL) Project (2003)

The MoTFAL project is a joint initiative of pedagogical, cognitive science and technological experts, educators, and psychologists to research the possibilities of using mobile platforms with Internet access for educational purposes at school level. It involved collaboration between schools in Greece and Spain. The students from Spain would take digital camera enabled PDAs (in the future this will include video) into archaeological sites in Spain. The students in their classroom in Greece would text requests for information and photos to the Spanish students who would then comply and respond. The students would also describe distances and send photos with students in front of artefacts to provide an idea of size. This process would then be completed in reverse.

LATVIA

PUMPURS - a national research project on m-learning services

Main Objectives of the project are:
- M-learning module delivery and exchange technologies
- M-course organisation and distribution approaches
- M-course design and development
- Methodologies and technologies for collaborative learning and virtual workgroups
- Knowledge creation models in a mobile Era
- Platforms for m-learning in a mobile society

The main output from the project is the development of the timetable centered m-learning environment. The project is aimed toward improvement of the full–time and part–time learning at the Faculty of Economics and Management by means of contemporary mobile technologies (and not at distance or lifelong education).

LITHUANIA

IMOTEC (Institute of Mobile Technologies for Education and Culture)

IMOTEC is a public non-profit institution offering guidance in advanced technologies and providing services, consultancy, training and development for continuing education learners. The Institute provides support for learners in their professional development in the area of computer skills and knowledge of information technology are concerned. The Institute targets include promoting international co-operation based on applying new technologies and internet tools, as well as develop and disseminate mobile learning tools. It has participated in several European co-operation projects as AITMES, CHIMER, or eMapps.com, all of which are described in other parts of this report.

POLAND
The use of ICT, games and mobile technology in the New Member States

eMapps.com (2005) is a project funded under the European Commissions IST 6th Framework Programme (FP6). It focuses on demonstrating how games and mobile technologies can be combined to provide new and enriching experiences for children in the school curriculum and beyond. Its work will concentrate initially on Europe’s New Member States and school children in the age group 9-12. It began work in October 2005 and will run for 30 months. The project has published a major deliverable containing three surveys on the status and use of ICT in the New Member states including games and mobile technology.

On the use of mobile technology the report gives the following information: Mobile phones are already being used in education, but so far the uses have been fairly modest e.g. ‘text alerts’ to parents and students. This kind of usage represents only a fraction of what mobile technology can potentially achieve in education. One of the most important qualities a mobile phone can offer is its context-awareness enabling more personal, spontaneous informal learning experiences situated somewhere more relevant than in a classroom, using camera phones to upload content immediately to a PC or server and staying in touch with tutors and other students whilst ‘in the field’.

Mobile phones, though actively used by learners, are not yet widely used for educational purposes. Consequently, most current school regulations rather focus on restricting their use during school time and lessons.

IV

Level 4 countries are those in which little or no activity in mobile learning has been documented. These countries are Belgium, Luxembourg and Romania.

BELGIUM

Extensive research failed to identify examples of mobile learning in Belgium.

LUXEMBOURG

Extensive research failed to identify examples of mobile learning in Luxembourg. The Ministry of Higher Education in Luxembourg confirmed to the project that there was no mobile learning in Luxembourg.

ROMANIA

The only activities uncovered by the project research in Romania are better classified as e-learning.

PART 3 PEDAGOGICAL ASPECTS OF MOBILE LEARNING

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Executive Summary
This report was commissioned to examine the Pedagogical aspects of mobile learning within the European Union. The research carried out by the partners of the project, draws attention to the current learning methodologies. We then look at current trends in mobile learning and discuss the proposal of a Mobile Learning framework.

The pioneering use of technology education has required a significant investment of time, energy, imagination and expertise to address economic, technical, social and pedagogical challenges.

The information on research was collected by the project team with strong support from a small group of experienced and expert researchers drawn from various parts of Europe who met with the project team and also prepared and submitted a large amount of evidence in the form of summaries of research reports considered to be potentially useful. It was found that some areas of potential interest were covered but others less so, and consequently it was decided to draw on research conducted elsewhere in the world if this added some new insight which might be appropriate to European circumstances.

The information on good practice was based on an initial literature search which led to the development of a framework. With strong support from existing research, the instruments were disseminated to experts in different member state. When the information had been analysed, a validation meeting took place involving the project team.

From the above analysis of research, good practice and principles, the following positive features seem evident: i) enormous variety of worthwhile activity; ii) continuing evidence that generally pupils’ attitudes and motivation are strongly positive when using new technologies.

The main points of the research are:

1. What is taught and what is learned?
2. The knowledge Society
3. Constructivism as the basis for a new pedagogy for mobile learning
4. E-Pedagogy
5. The changing technological environment
6. The emergence of mLearning
7. Adaptive learning Systems
8. Constructivism
9. m-Learning Framework
10. Strategic Aspects of Wireless and Mobile Learning

Chapter 1

What is Pedagogy? – Etymology

1.1 What is learning, and how to understand the learning process?
A fairly standard consensual definition is "a relatively permanent change in behavior (sic.; it's American of course) that results from practice." (Atkinson et al 1993). This is of course arguable, particularly the "practice" criterion. Others would accept changes in "capability" or even simple "knowledge" or "understanding", even if it is not manifest in behaviour. It is however an important criterion that "learned" behaviour is not pre-programmed or wholly instinctive (not a word used much nowadays), even if an instinctual drive underpins it. Behaviour can also change as a result of maturation—simple growing-up—without being totally learned. Think of the changing attitude of children and adolescents to opposite-sex peers. Whatever the case, there has to be interaction with the environment. We are indeed becoming more confused: evidence from genetics, evolutionary psychology and neuroscience is arguing ever more strongly for predispositions for our behaviour. Locke's tabula rasa is getting dirtier by the minute: this is one of those areas for which Mark Twain's (attributed) comment might have been coined: "Many researchers have already cast much darkness upon this subject, and it is probable that if they continue, that we shall soon know nothing at all about it"

Even if psychologists ever agree about what learning is, in practice educationalists won't, because education introduces prescriptive notions about specifying what ought to be learnt, and there is considerable dispute about whether this ought only to be what the teacher wants the learner to learn (implicit in behavioral models), or what the learner wants to learn (as in humanistic models).

**What is taught and what is learned**

It is a simple point that what is taught is not the same as what the students learn, but it does have a number of implications.
In the figure above, it is clear that some of what we teach is wasted effort: but the diagram is a representation of only one learner’s learning. It may be that within a class as a whole, everything we teach is learned, by someone. The shape representing the teaching is smaller than that for learning, because students are also learning from other sources, including colleagues and the sheer experience of being in the educational system, as well as other more conventional resources such as books.

It is an open question in any given case as to whether what they learn apart from what they are taught is a "good" thing or not. It includes the “hidden curriculum”, which is a phrase used by Snyder (1971) to describe what students learn by default in educational settings. His original observations at MIT in the late 'fifties were about how students with an over-loaded curriculum acquired survival tactics to get through their courses, such as mugging up only the parts which were likely to come up in the exams, and thus losing the point of much of the teaching. This selective learning is one of the characteristics of what is now called "surface learning", although that tends to be seen as an attribute of the learner — Snyder saw it as a problem of the institution.

From a sociological (Marxist) rather than primarily educational perspective, Bowles and Gintis (1976) suggested that all US schooling has a hidden curriculum dictated by the demands of a capitalist economy. More recently, critical theorists have sought to expose the hidden assumptions behind curricula (see, for example, Collins (1991) — see also Cultural Considerations). Some of the work seems marginal and academically political, but there is no denying that teachers' strategies, such as labeling, can have a profound effect on a student's experience. Claxton (1996) has convincingly
argued that adult learning is profoundly influenced by “implicit theories of learning” acquired at school, and that teachers tend to reproduce their implicit models in the ways in which they themselves go on to teach. An important piece of research was carried out by David Kolb 1984. David Kolb published his learning styles model in 1984. The model gave rise to related terms such as Kolb’s experiential learning theory (ELT), and Kolb’s learning styles inventory (LSI). In his publications - notably his 1984 book 'Experiential Learning: Experience as the Source of Learning and Development' Kolb acknowledges the early work on experiential learning by others in the 1900's, including Rogers, Jung, and Piaget. In turn, Kolb’s learning styles model and experiential learning theory are today acknowledged by academics, teachers, managers and trainers as truly seminal works; fundamental concepts towards our understanding and explaining human learning behaviour, and towards helping others to learn.

Kolb's learning theory sets out four distinct learning styles (or preferences), which are based on a four-stage learning cycle. (which might also be interpreted as a 'training cycle'). In this respect Kolb's model is particularly elegant, since it offers both a way to understand individual people's different learning styles, and also an explanation of a cycle of experiential learning that applies to us all.

Kolb includes this 'cycle of learning' as a central principle of his experiential learning theory, typically expressed as four-stage cycle of learning, in which 'immediate or concrete experiences' provide a basis for 'observations and reflections'. These 'observations and reflections' are assimilated and distilled into 'abstract concepts' producing new implications for action which can be 'actively tested' in turn creating new experiences.

Kolb says that ideally (and by inference not always) this process represents a learning cycle or spiral where the learner ' Touches all the bases', i.e., a cycle of experiencing, reflecting, thinking, and acting. Immediate or concrete experiences lead to observations and reflections. These reflections are then assimilated (absorbed and translated) into abstract concepts with implications for action, which the person can actively test and experiment with, which in turn enable the creation of new experiences.

Kolb's model therefore works on two levels - a four-stage cycle:

1. Concrete Experience - (CE)
2. Reflective Observation - (RO)
3. Abstract Conceptualization - (AC)
4. Active Experimentation - (AE)

and a four-type definition of learning styles, (each representing the combination of two preferred styles, rather like a two-by-two matrix of the four-stage cycle styles, as illustrated below), for which Kolb used the terms:

1. Diverging (CE/RO)
2. Assimilating (AC/RO)
3. Converging (AC/AE)  
4. Accommodating (CE/AE)

Kolb explains that different people naturally prefer a certain single learning style. Various factors influence a person's preferred style: notably in his experiential learning theory model (ELT). Kolb defined three stages of a person's development, and suggests that our propensity to reconcile and successfully integrate the four different learning styles improves as we mature through our development stages. The development stages that Kolb identified are:

1. Acquisition - birth to adolescence - development of basic abilities and 'cognitive structures'
2. Specialization - schooling, early work and personal experiences of adulthood - the development of a particular 'specialized learning style' shaped by 'social, educational, and organizational socialization'
3. Integration - mid-career through to later life - expression of non-dominant learning style in work and personal life.

Whatever influences the choice of style, the learning style preference itself is actually the product of two pairs of variables, or two separate 'choices' that we make, which Kolb presented as lines of axis, each with 'conflicting' modes at either end:

**Concrete Experience - CE (feeling) -----V-----Abstract Conceptualization - AC (thinking)**

**Active Experimentation - AE (doing)-----V----- Reflective Observation - RO (watching)**

A typical presentation of Kolb's two continuums is that the east-west axis is called the Processing Continuum (how we approach a task), and the north-south axis is called the Perception Continuum (our emotional response, or how we think or feel about it).

In the next section we can see that there are different aspects that must be explained and understood to fully grasp the learning process. From a psychological point of view, the following questions must be asked (Hagen, 2006)

**Identity**

- What are the influences on your identity?  
- How is your identity influenced by your ethnicity, cultural background, age, gender, peer group, religion, sexual orientation, etc.?  
- Who are you, who are you becoming, and who do you want to become?

**Learning Styles**

- What is your learning style?
Introduction to the Brain
• What do you wonder about the brain?
• Parts of the brain and their functions
• What does it mean to be “intelligent?”
• What happens if part of your brain doesn’t work the way it should?

Attention
• How attention helps you learn or make learning more difficult
• Common attention challenges
• Strategies for improving attention

Memory
• Understanding how memory works
• Different kinds of memory
• Strategies to help memory work more efficiently

Language
• Components of language (reading, writing, listening, speaking, understanding)
• Assessing one’s strengths and weaknesses in language
• Strategies for improving language skills

Social Cognition
• What are effective social skills?
• What makes someone popular?
• What makes someone a good friend?
• The role of peer pressure
• Strategies for succeeding in social situations

Learning Disabilities
• What are learning disabilities?
• How do learning disabilities affect one’s life in and outside school?

Putting It All Together
• Personal Plan of Progress

1.2 The Knowledge Society

The emergence of the knowledge society, building on the pervasive influence of modern information and communication technologies, is bringing about a fundamental reshaping of the global economy. Its significance goes well beyond the hyping of the Internet or the dramatic declines in the dot.com sector. What is underway is a transformation of our economy and society. Knowledge has always been a factor of production, and a driver of economic and social development. Earlier economies depended, for example, on knowledge about how to farm, how to build and how to manufacture. However, the capacity to
manipulate, store and transmit large quantities of information cheaply has increased at a staggering rate over recent years.

The digitization of information and the associated pervasiveness of the Internet are facilitating a new intensity in the application of knowledge to economic activity, to the extent that it has become the predominant factor in the creation of wealth. As much as 70 to 80 percent of economic growth is now said to be due to new and better knowledge.

Information and communication technologies (ICTs) are also facilitating a rapid globalization of economic activity. In an increasingly global economy, where knowledge about how to excel competitively and information about who excels are both more readily available, the effective creation, use and dissemination of knowledge is increasingly the key to success, and thus to sustainable economic and social development that benefits us all. Innovation, which fuels new job creation and economic growth, is quickly becoming the key factor in global competitiveness. Innovation fundamentally means coming up with new ideas about how to do things better or faster. It is about making a product or offering a service that no one had thought of before. And it is about putting new ideas to work in enterprise and having a skilled work force that can use those new ideas.

1.3 Constructivism as the basis for a new pedagogy for mobile learning.

Does e-learning require a new pedagogy?
The teaching methods employed in the classroom have changed little in the last century. The school-master from 1907 would feel at home in the classroom of 2007. Teaching is almost unique in this regard.

Somewhat belatedly, education is now going through its own transformation. The effects of information and communication technology (ICT) are beginning to impact on education in a fundamental way. While the environment in which learning takes place has been revolutionised, learning theories and teaching methods have not changed. Some say that there is no need to modernise pedagogy; others argue that pedagogy also needs to be updated.

Naismith et al (2004) introduced a classification of mobile learning activities where they categorised examples of learning via personal digital assistants (PDAs) and mobile ‘phones that involved children and the general public as well as university and college students, into six areas, four of which relate to the underpinning learning theory. These are behaviourist, constructivist, situated and collaborative. Two further categories relate more to context and application; informal and lifelong learning, and learning and teaching support. Of these six, the constructivist approach is most helpful in terms of describing learning with mobile devices. Behaviourism considers only the relationship between a student’s action and the response they receive without acknowledging any intermediary cognitive processing. And for me, situated and collaborative are more descriptions of ways in which learning may take
place that could themselves be built into a constructivist learning activity rather than grounding theories within themselves.

The constructivist approach to learning is based on Piaget's (1950) original descriptions of how a child constructs their own understanding, building on previous understanding, and is currently predominant within the UK education system. The UK National Curriculum itself is based upon Bruner’s (1966) ideas of a spiral curriculum where topics are revisited in turn at different ages in order to build upon previous learning. Papert (1980) himself built further on these ideas when he applied Piagetian theories to children’s learning with computers to create the concept of constructionism. Constructionist learning involves the learner making their thinking explicit by, for example, designing a program in LOGO. This also allows the learner to see the results of their thought processes making it easier to revise or ‘debug’ them and, hopefully, building metacognitive skills.

Mobile devices lend themselves to constructivism, initial teacher training (ITT) students on teaching placement using PDAs would make notes in separate files, and later, through a process linked to further research and reflection, reconstruct those notes into a reflective essay demonstrating their learning (Wishart, Ramsden and McFarlane, in press).

The effectiveness of these kinds of activities is reinforced by this student’s report “During teaching practice I have found myself constantly bombarded with new and noteworthy information (e.g. scientific facts, ideas for teaching approaches, school procedures, evidence for QTS standards etc.). The PDA has allowed me to keep meaningful notes of this information, and structure the information in a way that allows me to access it easily.”.

Another good example of PDAs being able to scaffold students constructing their own understanding is the use of Sketchy by school students. Whyley (2006), director of the Learning2Go Project where more than a thousand students in the UK have been using PDAs to support their learning lists Sketchy as a killer application for PDA use. He describes it as “A superb “Flickbook” animation tool, which learners enjoy using to illustrate their understanding of science concepts and other ideas”. Constructing an animation is particularly helpful in supporting understanding dynamic concepts in science.

Motivation to Learn with Mobile Devices Challenge, Curiosity and Complexity Bruner (1966) noted the importance of intrinsic motivation for learning in describing his technology of teaching, and proposed that the will to learn consists of both curiosity and the drive to achieve competence. These are produced, respectively, by the complexity and challenge of the task at hand. Later Malone (1981) applied both these concepts to explain the high motivation found in computer game players.

Malone (1981) explored the importance of cognitive, intrinsic rewards within the software as he analysed what makes educational computer games so involving for the player. He considers that the challenge of an educational
software program is made up of a number of goals which vary during the program thus maintaining uncertainty within the user as to whether they will achieve them. When computer games of the 1970s were assessed by American schoolchildren the presence of a clear goal produced the highest correlation with popularity. This was closely followed by whether the game kept a score which also provides further challenge. Malone adds that complexity created by the use of graphics and sound motivates the computer user through evoking curiosity to explore the software. Pupils using a multimedia application whether on a desk top or a handheld can be seen to be satisfying this visual or sensory curiosity to see what images and sounds there are as well as following up their cognitive curiosity to know more about a topic. Malone (ibid) also considered the presence of a coherent fantasy intrinsic to the game being played to be important but this is less pertinent to the everyday use of PDAs for learning and teaching support in schools and colleges.

A good example of software that has been seen to evoke each of challenge, sensory and cognitive curiosity in users is the wildlife identification guide Wildkey. On trials with 23 schools across SE England 100% of the school teachers involved agreed or strongly agreed that using handhelds running Wildkey for wildlife identification and location reporting motivated their students (Bailey, 2006).

Chapter 2

E-Pedagogy

2.1 Does eLearning require a new approach to teaching and learning?

The teaching methods employed in the classroom have changed little in the last century. The school-master from 1908 would feel at home in the classroom of 2008. Teaching is almost unique in this regard.

Somewhat belatedly, education is now going through its own transformation. The effects of information and communication technology (ICT) are beginning to impact on education in a fundamental way. While the environment in which learning takes place has been revolutionised, learning theories and teaching methods have not changed. Some say that there is no need to modernise pedagogy; others argue that pedagogy also needs to be updated.

2.2 The nature of learning

There are numerous theories of learning. For the purpose of this paper, I will explain the main three types, but will consider one: construction

1. learning as behaviour (behaviourism)
2. learning as understanding (cognitivism)

3. learning as knowledge construction (constructivism).

**Behaviourism**

This psychological theory asserts that learning manifests itself in behaviour (either changed or reinforced behaviour), and behaviour can be conditioned through a system of punishments and rewards. Desired behaviours can be encouraged through rewards; undesired behaviours can be suppressed through punishments.

Behaviourism is one of the oldest teaching methods. It is typified by rote learning, drill-and-practice skill acquisition, and a punishment-and-reward system of learning. It is commonly practiced in primary schools and, to a lesser extent, secondary education. Current assessment practice, in all sectors, exhibits a behaviouralist approach – rewarding success (with a “pass”) and punishing failure (by withholding certification).

Behaviourism cares little about the mental processes that take place within the learner, who is considered a black box. Conversely, the teacher plays a central role, being ‘master’ with responsibility for training the learner. In the behaviourist model, learning takes place in a highly controlled environment, through drill-and-practice techniques. It manifests itself through changed behaviours such as the acquisition of new practical or mental skills.

**Cognitivism**

Cognitive learning theories view learning as a process of understanding and internalising facts and concepts about the world around us. In the cognitivist model, knowledge and understanding are represented by discrete mental states; unique synaptic combinations that represent specific knowledge and understanding. Cognitivism takes a data processing approach to learning, with the learner being seen as a computer who inputs, processes and outputs information.

Cognitivism relies on both teacher and learner. The teacher provides content and leads learning (i.e. the creation of specific mental models); the learner is responsible for internalising the material presented by the teacher. In the cognitivist model, learning takes place when the ‘correct’ materials are available to the learner, and the teacher directs the learning. Cognitivism recognises the individual differences between learners, each having their own pre-conceived ideas and preferred learning styles. But knowledge remains essentially pre-determined, with the role of the teacher being to facilitate learning through a series of learning activities.

**Constructivism**
According to this theory, knowledge is entirely subjective, uniquely constructed by each learner through a combination of their existing knowledge and beliefs, and new stimuli. Knowledge is actively constructed by learners through a mental process of development through which learners build (“construct”) meaning and knowledge. Meaning is derived from current knowledge and beliefs, and is individually constructed.

Piaget’s (1977) notions of assimilation and accommodation describe how learning takes place. Assimilation refers to the integration of perceptions into existing mental models; accommodation involves the alteration of mental models to explain perceptions that would otherwise not be understood. Piaget asserts that learning occurs by an active construction of meaning, rather than by passive acceptance. He explains that when we, as learners, encounter an experience or a situation that conflicts with our current thinking, a state of disequilibrium is created. We must then alter our thinking to restore equilibrium or balance. To do this, we make sense of the new information by associating it with what we already know, that is, by attempting to assimilate it into our existing knowledge. When we are unable to do this, which psychologists call a state of cognitive dissonance, we accommodate the new information to our old way of thinking by restructuring our present knowledge to a higher level of thinking.

In the constructivist model, the teacher facilitates learning – but does not direct it. S/he creates an environment (which may include learning materials) that is conducive to learning – but does not mandate it. There is no right and wrong; no target state of mind (unlike cognivism).

Social constructivism is a variation on this model that focuses the social nature of learning. It emphasises the importance of culture, language and context in learning and borrows from Vygotsky’s ‘zone of proximal development’ (1978), which argues that students can master concepts that they cannot understand on their own with the assistance of adults or peers who are more advanced.

The changing environment

Most of the world has been undergoing a cultural revolution during the last 25 years. This revolution has affected the environment in which students learn and, arguably, affected the nature of learners themselves.

2.3 The changing technological environment

A crucial aspect of this revolution is technological change. The most recent developments on the Internet are labelled “Web 2.0”. Anderson (2007) describes six “big ideas” behind Web 2.0.

Perhaps the simplest way to explain Web 2.0 is to describe it as the “read/write web”; a web that facilitates participation and collaboration as well as information dissemination. This contrasts with the original “read only” web
(“Web 1.0”) where users were passive consumers of (other people’s) information.

Ubiquitous computing relates to the widespread distribution of computing devices. It is currently at an early stage although mobile technologies (such as smartphones and PDAs) are a clear pre-cursor to a ubiquitous environment, where intelligent devices are routinely embedded in everyday objects (such as clothing and cars). Ubiquitous computing heralds a fundamental shift in society from an analogue world to a digital one.

The changing nature of learners

The wider societal changes that are part of this cultural revolution have affected the attitudes of young learners, who are typically less respectful of authority, less tolerant of poor service, and more self-motivated than previous generations. The shift from factory worker to knowledge worker has resulted in a constant demand for re-training and lifelong learning, leading to a much greater proportion of mature learners entering and re-entering education. These older learners typically demand a flexible and relevant curriculum and one that recognises their existing experience.

New kind of learner

According to some commentators, the combined effect of these technological and societal changes is the emergence of a new kind of learner, variously described as “Millenials” (Oblinger, 2003), “Net Geners” (Barnes et al, 2007) and, most famously, “digital natives” (Prensky, 2001).

A common set of characteristics emerges from the literature with respect to their learning styles:
- skilled use of tools
- active learning rather than passive receiving of knowledge
- authentic learning experiences rather than contrived tasks
- construction rather than instruction
- task (not process) oriented
- search not memorise
- just in time learning
- doesn’t know answer but knows where to find it
- Google not libraries

In his paper Digital Natives, Digital Immigrants, Prensky (2001) argues that there has been a fundamental change in students.

“Today’s students have not changed incrementally from those of the past. A really big discontinuity has taken place. One might even call it a singularity – an event which changes things so fundamentally that there is no going back.
This singularity is the arrival and rapid dissemination of digital technology in the last decades of the 20th century.

He goes on to argue that: “... our digital immigrant instructors are struggling to teach a population that speaks an entirely new language.” Prensky touches on pedagogy when he describes how teachers must change: “Today’s teachers have to learn to communicate in the language and style of their students... going faster, less step-by-step, more in parallel, with more random access.”

### 2.4 The emergence of eLearning

As part of the technological revolution, the use of eLearning, or blended learning, is increasing. This is particularly true of Higher Education, which offers programmes partly or wholly online. In the future, eLearning is likely to be more widely used in the tertiary and school sectors. Another driver for eLearning is life-long learning, which requires on-going training and re-training of the adult workforce.

In many cases, eLearning is delivered through a virtual learning environment (VLE), which is a custom built environment designed for online learning. VLEs, such as Blackboard and Moodle, typically provide all of the software tools required for online learning such as communication and file sharing facilities. These environments are often modelled around the traditional campus, providing ‘virtual staff rooms’ and ‘online student common rooms’. E-portfolios provide the digital equivalent to the traditional paper portfolio; these typically provide online storage for a range of media types (such as drawings, photos and videos). Dedicated e-assessment systems, such as Questionmark, facilitate large-scale online testing, providing many of the question types that are familiar to teachers.

Some academics have pointed out the potential of eLearning to improve current practice. Garrison and Anderson (2003) write:

“E-learning has significant potential to alter the nature of the teaching and learning transaction. In fact, it has caused us to face up to some of the current deficiencies of higher education, such as large lecturers, while providing some possible solutions or ways to mitigate these shortcomings. Seen as part of pedagogical solution, e-learning becomes an opportunity to examine and live up to the ideals of the educational transaction described previously.”

### 2.5 New learning opportunities

The changing environment facilitates new kinds of learning. Teachers have traditionally focussed on content; indeed, many consider the identification and delivery of learning material to be their prime role. It is through this role that they seek to direct learning. But it has been argued that this traditional teaching skill is redundant in today’s information-rich learning environment. A handout on the assassination of President Kennedy cannot match the
resources that are available online, which typically include original text, audio and video materials. Some of this content is very high quality, even world class. The most talented Business Studies teacher would struggle to match an online master class in business management from Bill Gates.

Some commentators have suggested that the contemporary teacher should be more “guide on the side” than “sage on the stage”. The ready availability of information makes facilitation more important than direction. The pedagogic challenge is not too little information but too much. The contemporary learner does not need to be supplied with information; s/he needs to learn how to select from the vast amount of digital information available online. They need to acquire ‘new literacies’: digital literacy, media literacy and (particularly) information literacy, the last of which includes the ability to “learn to learn”.

The current educational system is highly synchronous. Everything runs to a timetable. But digital learning material is inherently asynchronous. Web pages can be accessed at any time; videos can be watched whenever a student chooses; and podcasts can be listened to on the bus. The efficacy of traditional timetabled content delivery is questionable. “Face time” might be better spent discussing rather than delivering content.

**New learning spaces**

The emergence of ubiquitous computing is creating new learning spaces. Location is less important as information is available in almost any location where there is an Internet or 3G connection – ranging from Starbucks to the school bus. And it’s not just the location of spaces that are changing. The spaces themselves are transforming. Virtual worlds (VWs), such as *World of Warcraft* and *Second Life*, are attracting millions of users, and these worlds offer rich learning environments with a degree of emotional involvement unmatched in traditional settings.

For example, *Second Life* provides an environment consisting of millions of real life users who select an avatar that interacts with this world. There are thousands of in-world locations to explore, ranging from a virtual Rome to the dance floor on the *Titanic*. Users interact by text or voice. Streaming audio and video are available in many locations.

The educational applications of these environments are only now being considered. These include role playing and game-based learning. Some academics have argued that VWs could replace VLEs. Writing about the emotional involvement inherent in VWs, Bignell (2008) writes: “Traditional VLEs lack this engagement. By fostering the learning experience we can utilise the virtual world to produce amazingly effective teaching.” And he is confident about the future of such learning environments:

“Is Second Life better than 2D web-based virtual learning [VLEs]? Not yet. Will it be better? Yes, almost certainly, because the interactions are richer, the content easier to provide, the platform cheaper, the students can be engaged more readily, the technology is more efficient, assessment is easier, playful
learning is afforded and tailored learning environments can be constructed for specific learning outcomes.

2.6 Towards an e-Pedagogy

While the tools for teaching and learning have changed dramatically during the last 20 years, the methods of teaching and learning have not. Traditional teaching methods have been applied to these new learning environments. The reasons for this are two-fold: firstly, there is no need to change the tried-and-tested pedagogies; and, secondly, there are no alternative methods. The proponents of change challenge both of these assertions.

Problems with traditional approaches

The critics of existing approaches to teaching and learning make two arguments: (1) they’re not working; and (2) they misunderstand the nature of the technological change.

There are numerous critics of the status quo with respect to learning within higher education. Garrison and Anderson (2003) summarise many of the criticisms when they write:

“To realise the potential of eLearning it is essential that we rethink our pedagogy. Education is about ideas not facts. Moreover, students in higher education are not receiving the educational experiences they need to develop the critical and self-directed high education skills required for lifelong learning. The current passive-information-transfer approaches to Higher Education are contrasted with the interactive and constructive potential of eLearning.”

Twist and Withers (2006) contrast the way teachers imagine students learn with the real way they learn. They call the ways in which young people actually learn the “hidden curriculum” – the “informal digital spaces”, such as Facebook and MSN, which students routinely use for social and educational purposes.

Although school and university pass rates are improving (DfES, 2007), employers complain about the quality of school-leavers and graduates. Many employers claim that they are not properly prepared for the modern workplace, lacking the communication and collaborative skills needed in the contemporary working environment.

The second problem relates to faculty’s view of new technology – as an educational tool, entirely separate from pedagogy. Some educationalists have claimed that this view is fundamentally flawed; that you cannot separate the medium (ICT) from the message (pedagogy). Cousin (2003) argues: “Pedagogies never live independently of the prevailing media. Technologies work dynamically with pedagogies, not for them, and in the process they become mutually determining.” She was particularly critical of contemporary VLEs: “VLE environments (sic) tend to be skewed towards the simulation of the classroom, lecture hall, tutor’s office and the student common room”; their
adherence to existing pedagogy (the “primacy of pedagogy” as she put it) and focus on enhancing existing practice offered “false protection to academics because they promise a stable transition in an inherently unstable process of change from one media age to another.”

The educational applications of virtual worlds illustrate this view. These environments provide new and unchartered territory for teachers – and one for which there is no pedagogy. VWs are not just another educational tool – they provide unique opportunities for teachers and learners, offering unprecedented levels of motivation and emotional engagement. They don’t “fit in” with existing pedagogies. Rather, they have the potential to radically alter the educational experience. In the age of Xbox and multi-channel TV, perhaps VWs provide a way for education to claim its share of students’ attention?

**New pedagogies and learning styles**

A number of new pedagogies have been proposed, all of which directly address the learning opportunities afforded by e-learning. Perhaps the best known of these is connectivism or network learning.

George Siemens introduced this theory in his paper *Connectivism: Learning as network creation* (2004) to address “the shortcomings of behaviourist, cognitivist and constructivist ideologies”.

Connectivism conceptualises knowledge and learning as a network, consisting of nodes and connections. Knowledge, at any point in time, is a particular (probably temporary) configuration of nodes and connections (a sub-network). Learning creates new connections between existing nodes (changes to existing knowledge) and/or creates new nodes (entirely new knowledge). Learning, therefore, is about network (node and connection) creation. His theory differentiates between data, information, knowledge and meaning:

- **Data**: raw elements or small neutral elements
- **Information**: data with intelligence applied
- **Knowledge**: information in context and internalised
- **Meaning**: comprehension of the nuances, value and implications of knowledge.

“Learning is the process of that occurs when knowledge is transformed into something of meaning.”

Connectivism embraces eight principles:

1. Learning and knowledge rest in diversity of opinion.

2. Learning is a process of connecting specialised nodes or information sources.
3. Learning may reside in non-human appliances.

4. Capacity to know is more important that what is currently known.

5. Maintaining connections is needed for continual learning.

6. Ability to see connections between ideas and concepts is a key skill.

7. Currency (accurate, up-to-date knowledge) is vital in learning.

8. Decision making is itself a learning process.

2.7 E-learning 2.0 and Assessment 2.0

‘E-learning 2.0’ (Downes, 2005) relates to the second phase of eLearning based around Web 2.0 technologies. It proposes that ‘e-learning 1.0’, which consists of VLEs, e-portfolios and other formal environments, be replaced by generic tools such as blogs, wikis, discussion forums and other Web 2.0 services. Similarly, in the paper entitled Assessment 2.0 (Elliott, 2008), it is argued that Web 2.0 services make better assessment tools than formal e-assessment software.

It has been argued that E-Learning 2.0 and Assessment 2.0 are inevitable evolutions of current practice (and will replace it); that ‘traditional’ VLEs and e-assessment systems are unnatural to students and cannot keep up with the rapid change (and growth) of Web 2.0 tools and services. Were this to happen, it would strengthen the case for connectivism since Web 2.0 can be seen a way of implementing this learning theory.

2.8 Adaptive learning Systems

Introduction:

Advances in computer technology, intelligent user interfaces, context modelling applications and recent developments in the field of wireless communications, have created a wide array of new possibilities for technology users. When these technologies started to be used in education, a new learning paradigm, mobile learning, emerged. Thus, many new issues emerge and need to be explored. In this paper I am interested, in particular, on adaptation in mLearning. While adaptation in eLearning systems has attracted much attention, mobile learning is still struggling with basic technological and pedagogical problems. In fact, learning in mobile settings introduces certainly new dimensions of adaptation. So, the relevant questions which need to be answered are: Did dimensions of adaptation in eLearning remain relevant in mLearning? What are the differences between adaptation in eLearning and mLearning systems? What to adapt in mLearning systems and how? Many issues regarding adaptive mobile learning systems have not exhaustively been covered. Therefore, we are interested in our researches to adaptive
mobile learning. Dealing with adaptation requires fixing initially adaptation dimensions. So, we begin with reviewing the literature in order to conclude most relevant dimensions in mLearning - those inherited from eLearning and those introduced by mobility.

Then, I suggest a general framework that presents how to deal with dimensions in adaptive mLearning systems. The framework assembles different adaptation dimensions (user’s model, user’s context, devices and connectivity) and kinds (content, navigation, interaction, collaboration and presentation) in mobile learning and shows relationships between them with respect to the pedagogical aspect. This framework is considered in our researches that are interested in developing mobile learning environments based on an adaptive content and adaptive learning activities. Until now, an adaptive hypermedia system based on user’s learning styles is already developed [Laroussi, 2001]. At present, our researches treat adaptive learning content and adaptive learning activities in mLearning.

**Mobile Age**

We are now entering the mobile age, where phones are carried everywhere, banks are accessed from holes in the wall, cars are becoming travelling offices, airplane seats are entertainment centers, computer games are handheld, and advertising is ubiquitous. We now have the opportunity to design learning differently: to create extended learning communities, to link people in real and virtual worlds, to provide expertise on demand, and to support a lifetime of learning.

The entertainments industry is comparable in size and complexity to the education sector. One hundred years ago people travelled to music halls or concerts to be entertained. Then broadcasting and the gramophone brought mass entertainment into every home. Now a second revolution is underway as the internet enables people to create and share entertainment media across the world.

**Adaptive learning Systems: from e to m**

In the glossary of elearningeuropa.inf, eLearning is defined as: the use of new multimedia technologies and the Internet to improve the quality of learning by facilitating access to resources and services as well as remote exchanges and collaboration. An eLearning environment is considered adaptive if it is capable of: monitoring the activities of its users; interpreting these on the basis of domain-specific models; inferring user requirements and preferences out of the interpreted activities, appropriately representing these in associated models; and, finally, acting upon the available knowledge on its users and the subject matter at hand, to dynamically facilitate the learning process. [Paramythis, 2004]

Accordingly, adaptive eLearning systems carry out adaptation in accordance with a user.
model [Laroussi, 2001] which constitutes the main dimension of adaptation in adaptive eLearning systems.

**What to adapt in eLearning?**

According to [Paramythis, 2004], during an eLearning session we can adapt: interaction, course delivery, content discovery and assembly, and, finally, collaboration support.

- **Adaptive Interaction** refers to adaptations that take place at the system’s interface and are intended to facilitate or support the user’s interaction with the system.

- **Adaptive Course Delivery** refers to adaptations that are intended to tailor a course (or, in some cases, a series of courses) to the individual learner. The intention is to optimise the “fit” between course contents and user characteristics / requirements.

- **Content Discovery and Assembly** refers to the application of adaptive techniques in the discovery and assembly of learning material / “content” from potentially distributed sources / repositories.

- **Adaptive Collaboration Support**, is intended to capture adaptive support in learning processes that involve communication between multiple persons (and, therefore, social interaction), and, potentially, collaboration towards common objectives. The availability of high bandwidth wireless channels - such as 3G-telecommunication infrastructure, wireless LAN- and the popularity of handheld devices, has opened up new accessible opportunities for education. The true potential of eLearning as ‘anytime, anywhere’ has finally started to be realised with the advent of mobile learning (mLearning). 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, 2002].

**What to adapt in mLeaning**

Mobile learning can be considered from two viewpoints:

The first one is a technical oriented perspective. It points out that eLearning simply becomes mLearning by creating an additional channel of access for mobile users with mobile devices - such as hand phones, PDAs or pocket PCs-. The content suitable for eLearning needs to be used and then available in mobile environment.
The second one is a pedagogical oriented perspective. It points out that mLearning supports a new dimension in the educational process. Development of new skills and approaches will be required to ensure the pedagogical effectiveness of mobile learning.

We are interested in both viewpoints in order to fix dimensions of adaptation in mLearning. We consider transmitted dimensions from eLearning and those raised up by learning in mobile settings. With greater restrictions posed on mobile learners due to time, space and varied technical solutions available in different circumstances, adaptivity is expected to play even a greater role [Kinshuk, 2003b]. In fact, interesting possibilities arise with adaptive mobile learning environments and additional issues that do not usually apply in eLearning environments become relevant.

The user model dimension of adaptation in eLearning is still relevant in m-learning [Bull, 2003]. However, supplemental features gain importance. In fact, the user model is extended with user’s contextual information.

Also, new dimensions of adaptativity, provoked by the mobility will appear. These are mainly: device dimension and connectivity dimension. [Trifonova, 2004] [Goh, 2002]

**The user model dimension**

Location and general context are new features to be considered. Indeed, some environments take the user’s location or some aspect of the general context into account, in order to present information or provide an interaction relevant to the learner’s situation. An illustration is [Zancanaro, 2003] a museum guide which uses infrared sensors in order to present multimedia information related to the fresco painting in front of which the user is standing. However, this kind of application does not necessarily adapt to the individual. All users in the same location may receive exactly the same information. [Jameson, 2001] argues for combining research in the fields of context awareness and user modelling. An example of such an approach is the LISTEN system [Zimmerman, 2003], which provides audio presentations according to the location and also the profile of a visitor to an art exhibition. These kinds of approach unite the fields of context awareness and user modelling in applications can be highly adaptive not only to relevant contextual information, but also to the needs or interests of an individual user. The features of learner context are mainly: location, level of noise, temperature, light, objects in proximity of the learner, motivation, level of concentration and so on.

**The device dimension**
It’s crucial to consider capabilities of user’s devise for the mobile learning adaptation due to the fact that they have a big impact on what content is possible and meaningful to be delivered. Mobile adaptation to devise should consider the device’s hardware and software attributes. **Hardware attributes** include: size and resolution of screen, Multilanguage capability, input possibilities (keypad, keyboard or pointer device), memory capability, processing power, cookies, supported media types and capabilities in presenting multimedia content, and so on. **Software attributes** include: operating system, compatible applications and so on.

### The connectivity dimension

It’s one of the main differences if we compare a mobile device with the PC (the usual medium for delivering eLearning). Nowadays mobile devices might be connected to ‘The Net’ via many technologies –WAP, GPRS, UMTS, Bluetooth, WiFi, etc. Mobile devices often have periods of disconnection, either intentionally (when the connection is too expensive) or not (when no infrastructure is provided). [Trifonova, 2004] [Goh, 2002] consider that under this dimension, there are four operating sub-dimensions. The user can operate in a real-time online sub-dimension mode. In this aspect, the operating connecting speed and throughput determine some of the adaptation capability such as multimedia representation or text-based representation. Another sub-dimension is the pre-fetching capability of the application. While static pages can be pre-fetched easily, interactive applications need further consideration such as the depth of pre-fetching. Here device capability and network reliability and connecting type are the main consideration for adaptation. The third sub-dimension is the off-line synchronization sub-dimension. Here the attributes of depth and encrypted cookies need to consider providing seamless adaptation especially for highly interactive application where parameters regarding users’ actions need to be returned to the server. The last sub-dimension is the channel sub-dimension. This sub-dimension represents the actual mode of connection between the users and the server. For example in a satellite connection the user can experience a longer delay than a cable connection and a hot spot Bluetooth connection might not be suitable to support rich multimedia. Mobile adaptation must take this dimension into consideration.
Chapter 3

Constructivist Learning

Constructivist learning has emerged as a prominent approach to teaching during this past decade. The work of Dewey, Montessori, Piaget, Bruner, and Vygotsky among others provide historical precedents for constructivist learning theory. Constructivism represents a paradigm shift from education based on behaviorism to education based on cognitive theory. Fosnot (1996) has provided a recent summary of these theories and describes constructivist teaching practice. Behaviorist epistemology focuses on intelligence, domains of objectives, levels of knowledge, and reinforcement. Constructivist epistemology assumes that learners construct their own knowledge on the basis of interaction with their environment. Four epistemological assumptions are at the heart of what we refer to as "constructivist learning."

1. Knowledge is physically constructed by learners who are involved in active learning.

2. Knowledge is symbolically constructed by learners who are making their own representations of action;

3. Knowledge is socially constructed by learners who convey their meaning making to others;

4. Knowledge is theoretically constructed by learners who try to explain things they don't completely understand.

With these common assumptions, teacher planning according to the Tyler or Hunter models is no longer adequate. Research indicates that few classroom teachers plan using these models anyway (Morine-Dershimer, 1979; Zahorik, 1975) and usually because of administrative pressure if they do (McCutcheon, 1982). However, few approaches are available for working with prospective teachers or new teachers to organize for learning. Simon (1995) and Steffe & Ambrosio (1995) describe their processes of planning for constructivist learning and constructivist teaching respectively, but these methods are complex and represent the thinking of experienced teachers.

We are proposing a new approach for planning using a "Constructivist Learning Design" that honors the common assumptions of constructivism and focuses on the development of situations as a way of thinking about the constructive activities of the learner rather than the demonstrative behavior of the teacher. Most conventional teacher planning models are based on verbal explanations or visual demonstrations of a procedure or skill by the teacher which are then combined with practice of this method or skill by the student. Much of this approach seems consistent with the description of classroom activities reported in a major research study titled A place called school conducted by Goodlad (1984). He found that most of the time, most of the
teachers talk to the kids. Students explained that physical education, fine arts, or industrial arts were their most interesting classes because they actually got to do something. They were active participants in learning rather than passive recipients of information. This is the primary message of constructivism; students who are engaged in active learning are making their own meaning and constructing their own knowledge in the process.

3.1 Constructivist theory

Formalization of the theory of constructivism is generally attributed to Jean Piaget, who articulated mechanisms by which knowledge is internalized by learners. He suggested that through processes of accommodation and assimilation, individuals construct new knowledge from their experiences. When individuals assimilate, they incorporate the new experience into an already existing framework without changing that framework. This may occur when individuals' experiences are aligned with their internal representations of the world, but may also occur as a failure to change a faulty understanding; for example, they may not notice events, may misunderstand input from others, or may decide that an event is a fluke and is therefore unimportant as information about the world. In contrast, when individuals' experiences contradict their internal representations, they may change their perceptions of the experiences to fit their internal representations. According to the theory, accommodation is the process of reframing one's mental representation of the external world to fit new experiences. Accommodation can be understood as the mechanism by which failure leads to learning: when we act on the expectation that the world operates in one way and it violates our expectations, we often fail, but by accommodating this new experience and reframing our model of the way the world works, we learn from the experience of failure, or others' failure.

It is important to note that constructivism itself does not suggest one particular pedagogy. In fact, constructivism describes how learning should happen, regardless of whether learners are using their experiences to understand a lecture or attempting to design a model airplane. In both cases, the theory of constructivism suggests that learners construct knowledge. Constructivism as a description of human cognition is often associated with pedagogic approaches that promote active learning by doing.

Social constructivism views each learner as a unique individual with unique needs and backgrounds. The learner is also seen as complex and multidimensional. Social constructivism not only acknowledges the uniqueness and complexity of the learner, but actually encourages, utilises and rewards it as an integral part of the learning process (Wertsch 1997).

An approach to learning developed by Seymour Papert and his colleagues at MIT in Cambridge, Massachusetts. Papert had worked with Piaget at the latter's Institute in Geneva. Papert eventually called his approach "constructionism." It included everything associated with Piaget's
constructivism, but went beyond it to assert that constructivist learning happens especially well when people are engaged in constructing a product, something external to themselves such as a sand castle, a machine, a computer program or a book. This approach is greatly facilitated by the ready availability of powerful 'constructing' applications on personal computers. Promoters of the use of computers in education see an increasing need for students to develop skills in Multimedia literacy in order to use these tools in constructivist learning. This is the point where we can focus on the use and importance of Mobile Learning.

ELearning (electronic learning) and mLearning (mobile learning) have started to emerge as potential educational environments supporting learning. Handheld devices or mobile devices, one of the most promising technologies, are here to support learning. Even though these new technologies offer new opportunities for individuals who require mobile computer solutions than other devices cannot provide, worldwide, these environments suffer from various technological as well as pedagogical problems.

3.2 The importance of the background and culture of the learner

Social constructivism encourages the learner to arrive at his or her own version of the truth, influenced by his or her background, culture or embedded worldview. Historical developments and symbol systems, such as language, logic, and mathematical systems, are inherited by the learner as a member of a particular culture and these are learned throughout the learner's life. This also stresses the importance of the nature of the learner's social interaction with knowledgeable members of the society. Without the social interaction with other more knowledgeable people, it is impossible to acquire social meaning of important symbol systems and learn how to utilize them. Young children develop their thinking abilities by interacting with other children, adults and the physical world. From the social constructivist viewpoint, it is thus important to take into account the background and culture of the learner throughout the learning process, as this background also helps to shape the knowledge and truth that the learner creates, discovers and attains in the learning process (Wertsch 1997).

3.3 The responsibility for learning

Furthermore, it is argued that the responsibility of learning should reside increasingly with the learner (Von Glasersfeld 1989). Social constructivism thus emphasizes the importance of the learner being actively involved in the learning process, unlike previous educational viewpoints where the responsibility rested with the instructor to teach and where the learner played a passive, receptive role. Von Glasersfeld (1989) emphasizes that learners construct their own understanding and that they do not simply mirror and reflect what they read. Learners look for meaning and will try to find regularity and order in the events of the world even in the absence of full or complete information.
3.4 The motivation for learning

Another crucial assumption regarding the nature of the learner, concerns the level and source of motivation for learning. According to Von Glasersfeld (1989) sustaining motivation to learn is strongly dependent on the learner's confidence in his or her potential for learning. These feelings of competence and belief in potential to solve new problems, are derived from first-hand experience of mastery of problems in the past and are much more powerful than any external acknowledgement and motivation (Prawat and Floden 1994). This links up with Vygotsky's "zone of proximal development" (Vygotsky 1978) where learners are challenged within close proximity to, yet slightly above, their current level of development. By experiencing the successful completion of challenging tasks, learners gain confidence and motivation to embark on more complex challenges.

3.5 Pedagogies based on constructivism

In fact, there are many pedagogies that leverage constructivist theory. Most approaches that have grown from constructivism suggest that learning is accomplished best using a hands-on approach. Learners learn by experimentation, and not by being told what will happen. They are left to make their own inferences, discoveries and conclusions. It also emphasizes that learning is not an "all or nothing" process but that students learn the new information that is presented to them by building upon knowledge that they already possess. It is therefore important that teachers constantly assess the knowledge their students have gained to make sure that the students' perceptions of the new knowledge are what the teacher had intended. Teachers will find that since the students build upon already existing knowledge, when they are called upon to retrieve the new information, they may make errors. It is known as reconstruction error when we fill in the gaps of our understanding with logical, though incorrect, thoughts. Teachers need to catch and try to correct these errors, though it is inevitable that some reconstruction error will continue to occur because of our innate retrieval limitations.

In most pedagogies based on constructivism, the teacher's role is not only to observe and assess but to also engage with the students while they are completing activities, wondering aloud and posing questions to the students for promotion of reasoning (DeVries et al., 2002). (ex: I wonder why the water does not spill over the edge of the full cup?) Teachers also intervene when there are conflicts that arise; however, they simply facilitate the students' resolutions and self-regulation, with an emphasis on the conflict being the students' and that they must figure things out for themselves. For example, promotion of literacy is accomplished by integrating the need to read and write throughout individual activities within print-rich classrooms. The teacher, after
reading a story, encourages the students to write or draw stories of their own, or by having the students reenact a story that they may know well, both activities encourage the students to conceive themselves as reader and writers.

Chapter 4
mLearning Pedagogical Framework

The pedagogical aspects related to mLearning is to find ways on how mobile devices can be integrated into educational/training activities as well as successfully address all the parameters related to and influence mobile devices integration in education. A pedagogical opportunity is that the m-learning widens the educational horizons of students as well as enhancing the educational options for educators.

Pedagogical aspects of mLearning are connected to the processes that identify the needs of the learners, choose appropriate technologies, and design motivating experiences that efficiently meet learning objectives and result in better learning outcomes.

While designing pedagogical framework, three main aspects should be taken into account:

- Existing models of exploitation of the potential of new technologies in pedagogy (eLearning), as well as the user requirements related to pedagogical framework
- Educational characteristics and existing pedagogical practices among the partnership.
- Components of a ‘best-practice’ eLearning pedagogical framework.

mLearning pedagogical framework could consist of five components:

- Pedagogical framework context; defines areas that influence the framework itself and forms the basis for further development. mLearning pedagogical framework context focuses on mLearning theory and practice, motivational factors, strengths and weaknesses of mobile learning.

- Pedagogical approaches; promote particularly principles of constructivist theory, along with blended, collaborative and active learning.

In a constructivist approach, learners are encouraged to be active constructors of knowledge, mobile devices embedding them in a realistic context, at the same time as offering access to supporting
tools. Compelling examples of the implementation of constructivist principles with mobile technologies come from a brand of learning experience termed ‘participatory simulations’, where the learners themselves act out key parts in an immersive recreation of a dynamic system.

- Assessment techniques; define and support diverse types of assessments. The question here is: if it’s possible to use eLearning scenarios like including computer-based assessment, self-assessment, peer-assessment and tutor assessment?

- Current pedagogical practices in the partnership countries; different aspects of national specifics (national curricula and educational policy plans, existing pedagogical practices in the partners organizations, technical infrastructure and future users).

- Teacher training; supports teachers’ work and endorse them during content production as well as delivery strategies decision. Techniques and methods to build a learning community and encourage the participants to explore the systems as well as the materials.

In general, the authors from the literature raise the following concerns/questions connected to the pedagogical aspects of mLearning:

4.1 How mobile devices can be used in education/training process?

The authors identify mainly two approaches to mobile devices integration: 1) as a supportive tool; and 2) as an instructional tool. As a tool to support educators mobile devices allow the recording and maintenance of the lessons take place, the instructional procedures, the type of mentoring and the pedagogical approach, the role of the teacher and students. Additionally, they facilitate communication between faculty members and students through file sharing capabilities, built-in networking and a friendly interface with on-line discussion and e-mail options.

On the other hand, mobile devices can be used as instructional tools to constructive learning. Mobile devices can be treated as tools that help students execute their tasks and promote the balanced development of their mental abilities by functioning as intellectual partners to the instructor and the learner. Educators can provide students with electronic books, conernet reference sites, graphing calculator, dictionary, and thesaurus etc. Finally, electronic quizzes and tests can be taken through mobile devices.

4.2 Curriculum and learning materials development

The new mobile learning arena imposes significant new design requirements of the curriculum per se. These requirements are not limited to the ways in which it is delivered and received but moreover in the ways the curriculum is structured and the ways in which it is maintained. Curriculum units can be project-oriented and designed by adding a technological angle in well defined
educational tasks. Furthermore, the social and the developmental value of each project task should be explicitly defined for each unit. Along the same lines, Colley and Steady (2003) address the need to produce innovative material that maintains a clear perspective on the learning goal. Activities within the curriculum can be designed to take place in classroom (deskwork) or mainly outside the classroom (fieldwork). It is unrealistic to support that mobile devices could be used for all classroom activities. As Carboni, et al., (2005) mention it is a complementary approach to the classic classroom lessons. It might not be able to deliver three hour course on a PDA but is it feasible to deliver small learning activities and a number of documents, and exercises. To produce materials and design the content to be appropriate to stimulate and support the learner, knowledge of the technological constraints should exist. Consequently, to produce acceptable learning materials for mobile devices there is a need for educators, engineers, and computer scientists to collaborate and coordinate their actions and activities.

4.3 In what contents mobile technology could be used?

The contents which mobile devices can be applied vary. Research so far shows that the experiments took place in various fields such as: Business and specifically MBA classes, Accounting, English, Social Studies, Mathematics, Science and Geography classes etc. Other activities include innovative games, exploring museums and exhibitions. Additionally, mobile learning devices can be used in order to evaluate students learning as well as assess attitudes to learning.

4.4 What pedagogical methods and instructional approaches could be applied?

Some might suggest that m-learning technologies support individualism while others might say that it facilitates the application of constructivist techniques where collaboration and team work is enhanced and promoted. There is a need for a shared, progressive pedagogy for mobile learning that will provide the scientific basis for networked and collaborative learning in both a virtual and a virtual-augmented environment. It must accommodate different teacher and learner perspectives, promote learner-centered environments and collaboration among learners and between learners and educators. Finally, the new pedagogy must support ambient learning.

4.5 What is the role of the educators and the students in the design, development and implementation of the innovation?

Educators should be involved throughout the entire process of designing, developing and implementing mobile technology integration. They need to ‘accept’ and ‘embrace’ this innovation in order to successfully integrate it in their teaching practices; otherwise they might boycott it as in some cases they did with computer integration. Educators’ feelings have to be considered regarding this innovation. Positive and negative reactions are expected to emerge.
Educators’ willingness to integrate mobile devices in their settings should be examined. Along the same lines, students should be also involved in the process of mobile devices integration. Students need to have direct input on the process and features being developed. Additionally, educators need to be trained on how to apply mobile devices in their practices. To integrate computers in classroom practices, researchers were addressing the need that educators should be computer literate; in this case they have to be mobile literate. This is a greater challenge because they have to deal with various types of equipment (hardware) and software. Additionally, as Alexander (2004) supports the role of the educators needing to move towards facilitation and not teaching.

4.6 Collaboration among various stakeholders: educators, students/learners, engineers, computer scientists.

Adopting an innovation is a risky process. But in order to minimize that risk and increase the success probabilities, it is important to be proactive and apply a systemic, holistic approach to mobile technology integration. The systemic approach to an innovation implies the involvement and participation of different parties in the design, development and implementation of the innovation. Various stakeholders such as educators, students/learners, computer scientists and engineers should collaborate. Their collaboration is a critical element to successful mobile devices integration in education. The above stakeholders need to communicate, coordinate their actions, transfer and share their knowledge and experiences, as well as align their needs and goals. Educators need the help, support and knowledge of engineers and computer scientists and vice versa. It is not feasible to achieve m-learning without the coordination and knowledge integration of the above fields.

4.7 What are the educational benefits and gains that can be achieved?

It is reasonable and expected that some researchers, educators and practitioners are wondering and trying to understand what the educational benefits from mlearning are. Research showed so far that through mobile devices reluctant learners can be motivated, hard-to-reach learners can be reached, various skills can be developed and improved as well as better communication among learners and between learners and instructors can be achieved. Consequently, there is a need for some experiments to take place in order to examine the integration of mobile devices and their effects on various parameters such as students’ learning, performance, and behavior, before moving further.

The implementation of the pedagogical framework is needed – we could use eLearning scenarios to implement the pedagogical framework and provide evaluation activities.
4.8 The need for a research in the pedagogical aspects of mLearning

Mobile devices are always available and can be used for a variety of learning functionality - providing access to content (both informational and instructional), review and assessment, and for communication and collaboration purposes. They can be used for formal or informal learning purposes as well as for performance support, i.e. for delivering information and support just-in-time and in context. Never in the history of the use of technology in education and training has there been a technology as available to citizens as mobile technology. It is clear that in the EU countries penetration is between 90% and 100%. Recent data from Telecom Austria shows that penetration of mobile services in Bulgaria currently exceeds 130%. It is time to incorporate these technologies into the curriculum and into our design of student learning (Litchfield et al, 2007).

Mobile devices are popular and well used by many people within mLearning project target groups. They are regarded as personal technologies, and as such likely to encourage a positive response. With the current rate of development, mobile devices will have the capability of delivering high quality, multi-media content at affordable prices within the next few years. If considering the fact that more people have mobile phones than computers we can assert that mLearning is more accessible than eLearning.

If we are interested in enhancing student learning, a priority must be to design mLearning and teaching strategies that involve active learning, for example, in experiential fieldwork, simulations, role-plays and games (Leigh, 2004). Learning and teaching strategies are needed that provide opportunities for learner adaptation and reflection (Laurillard, 1993), that encourage critical thinking, and that support students professional development through self and peer evaluation, feedback, review and assessment opportunities (Raban and Litchfield, 2007). Effective and practical strategies are needed that support learners to gain knowledge and skills in specific identified graduate attributes, curriculum objectives and stated learning outcomes.

In recent years there has been a lack of correspondence between the educational needs of the current generation of university students and much of the formal classroom education that takes place at universities. Ways of acquiring new knowledge for learners have been strongly influenced by the ICT’s with which they have grown up. As well as being adept with desktop computers, young people are high users of mobile devices. For them the small screen of the mobile phone is ‘a window to an infinite space’ through which they are able to undertake the following learning processes: listening, observing, initiating, questioning, reflecting, trying, estimating, predicting, practicing and ‘what-if-ing’ (Prensky, 2005). Nowadays learning can be characterized by a preference for receiving information quickly, coupled with the ability to process it rapidly; a bias towards multi-tasking and non-linear access to information; a heavy reliance on ICTs for information access and communication; and a preference for active involvement in learning over passive learning in lectures (Kennedy et al., 2006).
Trials in mLearning have been conducted at different universities in Australia, USA, Europe, (Litchfield at al, 2007) in order to extend the use of mobile devices and improve educational outcomes for the students. The trials showed that mobile devices can assist students to collect data in richer, multimedia formats and make subsequent classroom presentations of their field study much more interesting. However, it also showed certain usage and deployment issues with the mobile devices themselves, which were too difficult for most students to learn to use quickly in the short period of time they had. The authors conclude that device selection is crucial for the success of learning activities, and educational design should encourage students to use their own mobile devices which would be more familiar to the students and simpler to use.

There is a need to develop a new educational approach which will take into account the needs of the current learners’ generation, while also providing for the diversity of learning needs in the student population. Such an approach needs to adopt deep learning - an orientation towards understanding, personal sense-making and active learning – since this will achieve better learning outcomes than surface approaches of memorisation, reproduction of knowledge and a lack of personal engagement (Prosser & Trigwell, 1999; Marton & Booth, 1997; Ramsden, 1992).

‘mLearning’ is the facilitation of learning and access to educational materials for students using mobile devices via a wireless medium. There have been an increasing number of investigative studies of mLearning over the last few years, mostly in the USA, Asia, Britain, Scandinavia, and Australia. Several researchers have used surveys of students and university lecturers as their starting point for investigating mLearning. Their objective has been to ascertain the extent of mLearning in university education and also to investigate the potential for leveraging mobile educational practice from existing mobile use. With the exception of a few notable large-scale implementations of podcasting in the USA (Thomas, 2006), and leaving aside many short-term projects, the university sector has not adopted mLearning. Interviews of professors at eight universities in Australia, New Zealand and the USA conducted by Al-khamaysah, Zmijewska, Lawrence & Culjak (2006) showed that none had adopted mLearning despite widespread use of eLearning. Most surveys of students show that few students use their mobile phones for learning. mLearning is currently in an exploratory phase with universities unclear about the case for investing in a new set of expensive technologies, and educators still testing different delivery applications. Other surveys have concentrated on the issue of ‘threading innovative uses of technology into the existing fabric of behaviour’ (Pettit & Kukulsksa-Hulme, 2007). These user-centred studies have focused on uncovering students’ existing patterns of use and making these the basis for mobile education (Kennedy et al., 2006).

Of the mLearning projects found in the literature (Litchfield at al, 2007) the majority have been focused on improving interactivity in the classroom (Fujimura & Doi, 2006; Lindquist, Denning, Kelly, Malanai, Griswold & Simon, 2007) or on increasing students’ access to learning materials anywhere,
anytime (Barbosa, Hahn, Barbosa & Geyer, 2007; Cao, Tin, McGreal, Ally & Coffey, 2006). A smaller number of projects have focused on supporting on-the-job training in the field, largely for medical and nursing students in hospitals (Sommers, Hesler & Bostick, 2001; Sharple, Corlett & Westmancott, 2002; Kukulsk-Hulle & Traxler, 2005). A few projects have included teaching students some aspect of mobile technology, such as programming PDAs or using stylus technology, usually in connection with ubiquitous delivery (Bradley, Haynes & Boyle, 2005; Miertschin & Willis, 2004; Alford & Ruocco, 2001). Occasionally projects have combined ubiquitous delivery with a focus on interactivity, for example, Sá & Carrico’s mLearning framework (2006) although most studies have a single pedagogical focus.

There have also been criticisms of the methodology of some experiments. For example, Fies & Marshall (2006) note that most evaluations of mobile interactive classroom systems are flawed because they have focused on the comparison of traditional versus interactive teaching rather than mobile-supported interactivity versus interactivity with no mobile devices.

A small number of projects span more than one discipline area, for example Scheele, Wessels, Effelsberg, Hofer & Fries’s (2005) interactivity study in computer science and education. Most projects focus on only one type of mobile device although we note that the current ‘New Technologies, New Pedagogies’ project being conducted by the University of Wollongong examines three major devices - mobile phones, PDAs and MP3 players/iPods. Such project’s need to expand into multi-institutional, multi-disciplinary approaches so that the outcomes are relevant to the widest community possible, using actual case studies in real class situations over a variety of subjects and education environments ((Litchfield at al, 2007).

There are identified specific problems in university learning that mobile technologies can help overcome, for example, limited real world context, limited access to learning resources, low student engagement in classes, and lack of practical experience in learning about mobile technologies.

Looking at the available studies on mobile learning above and more: Copley 2007, Gaskel, 2007; Roschelle, Sharps & Chan, 2005; Siemens, 2006; Sharple, Taylor & Vavoula, 2008, two main issues could be identified:

- lack of operationalization of the referred theories into concrete learning design guidelines;
- evaluation of the effectiveness of the proposed mobile learning approaches is hard to find, and where it was the case, no strong research design was applied.

The goal of the pedagogical framework of mLearning within this project is to define the pedagogical aspects of using mobile devices for learning purposes in different educational and training contexts. mLearning pedagogical framework includes:

- pedagogical framework context,
- pedagogical approaches,
• assessment techniques;
• current pedagogical practices,
• teacher training.

4.8 The need for a revision existing pedagogies and learning theories

Emergent technologies for learning demand that educators revisit existing pedagogies and learning theories. Those existing pedagogical frameworks may no longer be sufficient when learning is delivered using mobile devices. To continue to subscribe to existing models and practices of teaching and learning is to limit the learning experience afforded by these brave new technologies. In order to exploit the full affordance of mobile technologies it is necessary, at the very least, to re-examine existing pedagogies. Conversely, the phrase” Pedagogy before technology” is presented by Beetham and Sharpe, in their introduction to Rethinking pedagogy for a Digital Age. The suggestion being, rather than creating a new pedagogy for new technologies, it better serves the practitioner to locate new technologies within “proven practices and models of teaching”.

An evaluation of the impact of the Gutenberg printing press on learning, a study of how papyrus and paper first impacted learning, an analysis of the impact of mobile devices on learning, all of these innovations impact the learning process. The concept of mobile learning, knowledge on the move, has been described as nothing particularly new, (Denk, M., Weber, M, and Belfin, R. IJMLO pg 122-139 Vol 1. No 2). If mobile learning has existed for some time, a new technological innovation is unlikely to cause a paradigm shift, with subsequent requirements for a new pedagogy.

The use of the word “pedagogy” in the field of mobile learning has given rise to debate about whether it is an appropriate term in a learner centred environment. The etymological basis of the word can be traced back to the Greek Paidagogos, i.e. the person who led the children paidia to school. “Pedagogy” can be taken to mean the art or science of teaching. This interpretation gives rise to questions in the vein of whether an equivalent term should be coined to focus on the art and science of learning, thereby bringing the focus back to the learner. From this, we can infer that teaching and learning are sometimes in tense opposition to each other. For the purpose of this proposal, pedagogy is taken to mean the underpinning models, practices and philosophy of both teaching and learning which structure the organisation and design of course content. These values, conscious or subconscious structure and shape every teacher and student's approaches to and expectations of learning.

The project research will be based on an analysis of the current literature on pedagogy and a review of existing studies on the pedagogical elements and the affordance of mobile technologies in a learning environment. The research will commence with an overview of objectivist schools of thought, those belief systems which hold that meaning exists in the world
independently of experience. An analysis of the learning theories founded on Behaviourism, Pavlov’s models and the S-R position as theories of learning will mark the beginning of the pedagogical study. The implications of this school of thought on the design of a mobile course will be analysed. For example, a course designed on Behaviourist principles may be structured to ensure the student acquires a body of knowledge through exposure to and mastering of the “correct” information. Experience of the world and individual interpretations of a body of knowledge will not be deemed significant. It is assumed that students may passively acquire their knowledge base from an authority figure or professor who lectures in a classroom type environment.

It is the author’s intention to then move to an analysis of Constructivism as the basis of a pedagogy to inform or structure learning in a mobile environment. From radical constructivism, which denies the existence of an external reality, to a more measured approach, the basic tenets and standpoints will be examined in terms of how they may inform a pedagogy for mobile learning. The rejection of an ultimate shared reality as expounded by radical constructivists is an extreme standpoint; more measured exponents of constructivism acknowledge the existence of an ultimate shared reality. In this, more tempered view; each individual through their learning activities imposes meaning on the world. The learner through his or her learning activities imposes meaning on the world. The learners construct their knowledge and understanding through the learning experience, this knowledge is constructed rather than discovered.

These principles of Constructivism along with the main tenets of Connectivism as expounded by George Siemens in his book *Knowing Knowledge* will inform the development of a pedagogy for a mobile learning course.

The basic tenets of these schools of thought may form the framework of pedagogy for mobile learning with far reaching implications. Examples are incorporating the need for students to acquire multiple perspectives or viewpoints on subject matter into the design of the mobile learning course. Also, the requirement to abandon rigid pre specified learning objectives will be examined, and how this will impact on the development of a mobile learning course.

In the Constructivist world, it is vital that students create or construct their own knowledge. Sitting in a classroom and passively receiving knowledge from an authority figure is not in keeping with the principles of Constructivism. Interactivity is emphasised, however, it is important to acknowledge that this requirement for interactivity is not merely satisfied by the adoption of a mobile technology into the classroom environment. It is incumbent upon the designers of a mobile learning course to ensure that students are truly able to interact with the digital media in their learning environment. These media as accessed through the mobile technologies, whether video, digital or audio are important aspects in the creation of a learner- centred environment. The overriding importance, however, lies not with the technology, nor the digital media, but with the knowledge constructed by the students as they interact with these tools.
The pedagogical framework informed by the Constructivist and Connectivist school places the student at the centre of the learning process. Because emergent technology is exiting and newly available, it is easy to become absorbed by the technology itself. This is true both for researchers in the area and for students employing mobile technology as learning tools. However, it is important that the technology itself does not become a distraction or a diversion. Again, poorly designed or ill structured mobile courseware or a Virtual learning Environment (VLE) may lead to frustrations and anxieties as students attempt to familiarise themselves with the system. Educators, developers and designers who strive for mobile learning environments with a sound pedagogical basis will take pains to avoid this occurrence. “An environment of tool should not be a hindrance, but rather an instrument for thinking and problem-solving (Fjortoft and Sageie, 2000)

A sound pedagogical framework based on developing the student’s ability to think creatively and form multiple perspectives on subject matter requires courseware incorporating tasks and subject matter that are authentic and based in the real world. It is not sufficient to develop a series of exercises that demand completion simply for the aim of applying a principle of knowledge. It is incumbent upon educators and developers to draw the tasks from those that the student would be likely to encounter in a real world environment.

A personalised approach to learning is central to a pedagogy based upon the principles of Constructivism and Connectivism. The mobile device is a pedagogic tool that enables students to acquire knowledge at a personal level. In order to offer a truly personalised experience, it is necessary to first understand the learners existing skills and interests. The Futurelab report Towards New Learning Networks advocates the following “Currently most discussions about increasing learner ‘choice’ and ‘voice’ are focused around giving learners a greater variety of routes through predetermined and predefined subjects and curriculum content. However, a truly personalised system requires that learners will not only have greater choice and influence over the pace, style and content of learning but that they are also supported to become active partners in developing their own educational pathways and experiences”.

This vision of students developing their own educational pathways requires that universities and colleges fully commit to the political agenda of personalisation. A starting point may be established in the creation of mobile learning courseware that exploits the affordance of mobile technology to personalise the learning experience.

A pedagogy that advocates personalised learning is one that also by necessity advocates a move towards more informal learning environments, moving outside the classroom. The mobile device is the ideal tool to foster informal learning. The mobile device affords location independent access to information services. “Professional knowledge is there for a purpose – to be used when professionals need to respond effectively within professional roles” Rhoda Sharpe and Martin Oliver consider Erut’s influential views on professional knowledge in Rethinking Pedagogy for a Digital Age. “Learning knowledge and using knowledge are not separate processes but the same
process. The process of using knowledge transforms that knowledge so that it is no longer the same knowledge”. Sharpe and Oliver point to various studies to demonstrate difficulties encountered by professionals when asked to explain how they are applying their knowledge and making decisions. They write that tacit knowledge is unexpressed and difficult to capture, posing difficulties when attempting to design effective case studies for students to study. This leads the authors to advocate professional development that takes the form of observation, conversation or shared participation, all informal styles of learning, learning through social networks to access the knowledge of colleagues.

The formal and informal divide in learning is an interesting debate, however, it is also useful to view the difference as less of a tension and see these forms of learning as a continuum. Sharples, Taylor and Vavoula in their paper “A Theory of learning for the Mobile Age” postulate a theory of mLearning in order to differentiate it from other forms of learning. The fact that mLearning is “labile” is not enough to distinguish it, learning is cumulative and occurs over a lifetime – we obtain our skills and ideas in one location and “apply and develop them in another”. Mobility in itself is not the key to the difference, but by focusing on mobility we can, according to the authors, gain a better understanding of how knowledge and skills can be transferred across different environments and “life transitions” and how technology can aid us as a mobile society seeks to “cram learning into the gaps of daily life”. A second criteria in their search for a theory of mLearning is the acknowledgement that much learning takes place outside the typical learning environment, from cafes to cars, locations which are described by the authors as “impromptu sites of learning”. Thirdly, the authors point to those practices that best enable successful learning and deduce that the social-constructivist approach is one which fosters successful learning. The last factor in their attempt to postulate a theory of learning is the ubiquitous use of personal and shared technology. The authors point to the convergence between new personal and mobile technologies and “new conceptions of learning as a personally-managed lifelong activity”.

4.9 Pedagogical aspects of mLearning

The debate on the main identified issue is centred around two questions: (a) what are the relationships between pedagogical approaches and technological affordances of mobile devices? and (b) which are the concrete characteristics of the pedagogical approaches that inform the instructional design guidelines for technology-enhanced mobile learning?

The debate on the pedagogical aspects of mobile learning is constrained by a ‘either-or’ type of argumentation about what is first, pedagogy or technology. Such a debate is not productive and reduces the chance of finding effective, efficient and appealing design solutions for mobile learning. Some of the existing traditional pedagogical approaches obviously are not appropriate for mobile learning. A survey conducted by Copley (2007) to measure the effect of audio and video podcasts on students’ achievements and attitudes indicated that the approach was not effective in facilitating mobile learning.
The very likely reason for this result is that just recording lectures as podcasts is not a really challenging pedagogical approach to explore the full potential of mobile learning. Such results should be expected recalling the findings of an extensive meta-analysis study on the role of technology on learning (Russel, 2001, WCET, 2006; see also the study of Clark, 1994; and Kozma, 1994). The lessons from the past should carefully be analysed to avoid possible disillusionments. One of the findings is that the success of learning technologies depends on the extent to which they take into account the existing learning context (Bransford, in press; Copley, 2007; Lee & Chan, 2007). It seems that neither teachers, nor students are prepared to fully benefit from mobile learning. Perhaps it is not only a question of using mobile learning for knowledge and skills acquisition, but rather changing attitudes and mental sets towards learning and teaching. It is not technology or instruction alone that is the issue, but the need to find a right combination of both. Research on the effectiveness of mobile learning should analyse the conditions under which particular technology-instructional method combinations have an effect not only on different learning outcomes, but also on mental effort, satisfaction and invested time.

Most of the studies on the pedagogical aspects of mobile learning bring and maintain the discussion on a very general, paradigmatic level as little attempt is made to move to more concrete learning design level. (Copley 2007, Gaskel, 2007; Roschelle, Sharps & Chan, 2005; Siemens, 2006; Sharples, Taylor & Vavoula, 2008). Reasoning about which of the theoretical paradigms – behaviourism, constructivism, or the newcomer, connectivism, is more appropriate for mobile learning is certainly important to discuss. More important, however, is to operationally define them in concrete instructional design steps, guidelines, and structure of content, whose effectiveness, efficiency and appealing is further a subject of experimental investigation.

The traditional instructional methods apparently do not serve the purpose of mobile learning, but there are a number of pedagogical approaches which may match nicely to the technical affordances of mobile learning. Some examples of such approaches, but not limited to, are minimalism (Carroll, 1998), cognitive load theory (Sweller, 1994; see also Clark, Nguyen & Sweller, 2006)), anchored learning (Bransford et al, 2005), cognitive apprenticeship approach (Brown, Collins, & Duguid, 1996; 2002) jigsaw teaching (Bransford, in press), theory of problem solving cognitive style (Kirton, 2003), performance support system approach (Gery 2002; Greenberg & Dickelman, 2002), cognitive flexibility theory (Spiro & Jehng), peer teaching and assessment (Bransford, in press), and a set of principles (effects) of multimedia learning (Mayer, 2005) such as split-attention principle, modality principle, redundancy principle, segmenting, sequencing and learner pacing principle, guided-discovery principle, work-out example principle, and collaborative principle. The analysis of these theoretical approaches would identify the underlying principles that could be further used to formulate instructional design guidelines for constructing a mobile learning scenario. What follows is a possible blueprint of a such scenario. The scenario always begin with building challenges, which should resemble, as much as possible, workplace referent situations (anchored learning, cognitive flexibility theory,
guiding-discovery principle of multimedia learning), then students collect the resources for the challenges, which could take any format (text, audio, video). An important part in tackling the challenges are just-in-time, just-enough, and just-at-the-point-of-need advice (performance support system, worked-out example principle of multimedia learning) by experts (cognitive apprenticeship) and peer teaching from the fellow students (peer teaching and assessment). Experts and fellows help to build a multiple perspectives view on the issue under investigation (cognitive flexibility theory). Students work first individually and then in small groups (collaboration principle of multimedia learning). Working in groups they get hints and learn how to manage the diversity of cognitive styles in order to cooperate effectively (jigsaw teaching, theory of cognitive styles for problem solving). The messages for mobile communication are based on some of the principles of minimalism (use as few words as possible, break the text into small, self-contained modules, usually no more than seven steps for procedures), cognitive load theory and multimedia learning (split-attention principles, modality principle, redundancy principle and segmenting, sequencing and learner pacing principle).

Mobile technology offers unprecedented possibilities for combining the strengths of formal and informal education, and professional internship. This technology connects people working at different places (formal, informal, workplaces) with opportunities for expert and peer feedback and co-learning. Some ideas to enrich this scenario could be borrowed from Bransford et al (in press).

Lee and Chan (2007) have critically analysed the widespread believe on the technical affordances, which each mobile learning application should posses to facilitate learning. These attributes are spontaneity, personalization, informality, context-sensitivity, portability, ubiquity and pervasiveness. The analysis revealed that personalization and informality are not specific for mobility learning and they have already been achieved without using mobile technology. Portability, ubiquity and spontaneity are really unique technical mobile affordances but in practice they have coupled with inadequate instructional design solutions, as traditional desktop-based e-learning activities and content are just repackaged for a mobile platform leading to unsatisfactory results from pedagogical point of view. The assumption of the authors, shortly defined as ‘learning on the move, while in motion’ is that the design of pervasive, life style-integrated mLearning providing short, bite-sized pieces to facilitate educational moment, will gain an increase in learning achievements. The study to test this hypothesis, returned some encouraging results regarding the uptake levels and perceived effectiveness, but also some findings, which are not consistent with the pervasiveness of mLearning. People still preferred to listen to the podcasts using a desktop/laptop computer, at home in a dedicated time for it, and to manually download MP3 files via a web browser instead of taking advantage of the options offered by RSS (Really Simple Syndication). Lee and Chan struggled, in their initial attempts, to give a satisfactory explanation of the low score on multitasking, which is one of the operationalizations of the pervasiveness. Their conclusion is that rhetoric rather than empirical evidence is used to back the claim that “modern mobile technologies are time-savers, which allow students to multitask and promote a high level of life-style integration (p. 213)”. In fact,
cognitive load theory and some of the principles of multimedia learning such as the split-attention effect can perfectly explain the results, if these theoretical constructs were taken into account in the design of mobile learning episodes. It is an example how such ‘middle level’ theories which were listed above, could help the design and development of mobile learning applications.

Evidence-based conclusions about the effectiveness of mobile learning depends on how comprehensively and deeply the theoretical construct of mobile learning is defined and how well this phenomenon is operationalized in the terms of a research design - a right selection of type, sampling, variables, measurement instruments, procedure and data analysis.

Evaluation has been an underestimated issue in the reports on design, development and using mobile applications for educational and training purposes. It was either not discussed at all or when evaluation was reported, it had serious methodological flaws. In most of the cases the research methodology was a case study with one group as self-reporters as the preferred method for data collection. To our knowledge, there was no experimental study involving a control group. The studies returned inconsistent findings. While there was an overall enthusiasm among students to see more traditional learning materials transformed into mobile learning formats, the majority of students still see them as supplementary to the traditional forms mostly for revisions/preparation for assessment. A very low percentage of students indicated that mobile learning would increase their likelihood of not attending lectures (Copley, 2007). Very few students reported that they use mobile learning devices when engaging with other tasks. These results are in line with the conclusions of Lee and Chan (2007) on the very low number of students multitasking while using mobile learning devices. An interesting result of this study is that students were not prepared yet to use the full potential of mobile learning defined as ‘learning on the move, while in motion’.

4.10 mLearning pedagogical framework

A mLearning pedagogical framework could consist of five components:

- Pedagogical framework context; defines areas that influence the framework itself and forms the basis for further development. mLearning pedagogical framework context focuses on mLearning theory and practice, motivational factors, strengths and weaknesses of mobile learning.

- Pedagogical approaches; promote particularly principles of constructivist theory, along with blended, collaborative and active learning.

In a constructivist approach, learners are encouraged to be active constructors of knowledge, mobile devices embedding them in a realistic context, at the same time as offering access to supporting tools. Compelling examples of the implementation of constructivist principles with mobile technologies come from a brand of learning experience
termed ‘participatory simulations’, where the learners themselves act out key parts in an immersive recreation of a dynamic system.

- Assessment techniques; define and support diverse types of assessments. The question here is: if it’s possible to use device-based assessment, self-assessment, peer assessment and tutor assessment?
- Current pedagogical practices in the partnership countries; different aspects of national specifics (national curricula and educational policy plans, existing pedagogical practices in the partners’ organizations, technical infrastructure and future users).
- Teacher training; supports teachers’ work and endorses them during content production as well as delivery strategies decision. Techniques and methods to build a learning community and encourage the participants to explore the systems as well as the materials.

Chapter 5

Strategic Aspects of Wireless and Mobile Learning

In looking at the strategic aspects of wireless and mobile learning, we move to perspectives governed by concerns rather different from those of technology, learning and teaching. These are in many senses the context and the environment for the technical and the pedagogic aspects. They include:

Resources: meaning obviously finance and money but also human resources, physical estates, intellectual property and expertise.

Culture: meaning institutions as social organisations, their practices, values and procedures, but also their culture, that is the norms, expectations and standards of their staff, students and their wider communities, local, national and virtual.

In looking at these wider aspects of wireless and mobile learning, it is easy to start addressing far wider – too wide - questions of the processes of organisational change within post-compulsory education. To avoid this we should bear two questions in mind: does technology-based change in education differ from any other organisational change? And, does wireless and mobile-based change in education differ from other technology-based change?

Literature: there is a considerable and highly relevant literature around the issues of ‘the diffusion of innovations’ especially technological ones within organisations (starting from Rogers’ seminal work, 1962), and of ‘Academics Response to Change’ (e.g. Trowler, 1998 and then, Knight & Trowler, 2001), some identified in the References and Resources section. Any attempt to understand, implement or change wireless and mobile learning within further, higher and community education must address the influence of technical and pedagogic concerns and also social, cultural and organisational factors.
These can be formal and explicit or informal and tacit and can vary enormously across and within institutions.

5.1 Strategic Overview – Some Themes

In the course of looking at the strategic aspects of wireless and mobile learning, several themes have emerged. Institutions hoping to enhance and support learning with wireless and mobile technologies will need to recognise the significance of these and a number are identified below.

5.2 Projects

Projects, in this sense, are fixed-term and small-scale, with access to specific funds, expertise and enthusiasm. Projects usually refine or answer specific research questions, demonstrate specific technological or pedagogic possibilities and generate academic output.

Current projects in wireless and mobile learning are mainly ‘first-generation’, meaning that their focus is frequently on making the various technologies work, ensuring learning happens and satisfying funding conditions. These projects do not usually address issues of scale, embedding or quality, and technical challenges that often squeeze the time and resource available for evaluation. Consequently identifying explicit and objective improvements or costs can be problematic.

In these projects, wireless and mobile learning are usually implemented as enhancements or extras to core provision, often as a variation of conventional eLearning rather than as a new form of pedagogy. The most exciting, innovative and convincing examples of wireless and mobile learning are projects where new forms of learning are created, rather than where existing forms of learning are reversioned and ported, but these are most problematic in terms of institutions being able to guarantee the standard and quality of learning for their students.

Projects can sometimes form part of an institution’s ‘project economy’ where researchers move on, and developments are not consolidated but they are nevertheless a useful way for institutions to gain experience of wireless and mobile learning. Information on projects can best be found in the relevant conference proceedings (e.g. Attewell & Savill-Smith, 2004).

5.3 Niches

Niches, in this context, are small-scale but sustainable initiatives, sometimes growing out of successful projects, based around a limited number of specific funding models. These models include:

- Specific subjects, for example, nursing, teaching practice, or medicine, where funding comes via training/professional agencies. Here wireless
and mobile learning has self-evident virtues in enhancing effectiveness and efficiency, by delivering content and sustaining communications where these would otherwise be difficult or impossible.

- Specific pedagogies, for example, fieldwork, field trips, outdoor pursuits, work-based learning, based around the ideas of situated or authentic learning, and for example, reflective logs, self-evaluation, e-portfolios based on the personal, immediate and accessible nature of mobile devices.

- Particular constituencies of learners who are prioritised and/or resourced, for example:
  - the Equal Opportunities, Assistivity, or Widening Participation constituencies where public funds support an inclusion agenda
  - full-cost courses, for example MBAs, where institutions use wireless and mobile learning to add value to their courses and compete with other institutions in the market-place.

In the context of the current UK resourcing and structuring of further, higher and community education, there is unlikely to be general and over-arching support for institution-wide wireless and mobile learning. However, an understanding of the possibilities for sustainable wireless and mobile learning may allow institutions to support specific learners and specific learning in a sensible and effective fashion.

### 5.4 Producers, Manufacturers and Developers

The wider technical and commercial worlds of wireless and mobile technologies are important because they have considerable influence on the effective and increased deployment of wireless and mobile learning. The champions and managers of wireless and mobile learning within further and higher education must be alert for trends and developments.

Many hardware manufacturers see their mainstream wireless and mobile markets as technology-driven, highly segmented and very volatile, whilst seeing the further and higher education markets as fragmented and opaque, working to timescales, budgets and priorities unlike those of any retail or commercial markets. Some of these hardware manufacturers react to these perceptions by treating further and higher education as markets of secondary commercial importance whilst a very few have created models of constructive engagement and communication that open up possibilities for mutually beneficial collaboration. It would obviously be ultimately beneficial for learners if there were increased understanding and communication between producers, manufacturers and developers on the one side and further and higher education on the other, and there is perhaps a role for a national forum.

Some of the relatively few developers of software and content for mobile platforms predict a continuation of project-based funding, focussing on engaging new learners and delivering standalone content. They anticipate
that some public funders will continue to support exploratory work in order to define the potential of wireless and mobile learning and that there will be a small but growing demand for the localisation and customisation of content, and for more support and training for teachers and lecturers. Institutions of further and higher education should be aware of these possibilities opening up.

The issue of standards is however problematic for developers working in wireless and mobile learning, since many of the technologies are immature, unstable and short-lived, requiring considerable developmental agility. Standards are seen as a potential brake on development, and interoperability may be best achieved using the levels of abstraction provided by browsers and other industry-standard software systems. Institutions of further and higher education should perhaps treat the standards issue pragmatically in order to encourage experimentation and evaluation.

Many different industrial trainers see a growing market for just-in-time training and performance-support delivered on wireless and mobile technologies for private sector organisations. The development of wireless and mobile learning in further and higher education could exploit some of the models of mobile training used in the private sector but might also market its own models of wireless and mobile learning to companies and corporates.

5.5 Institutional Perspectives

In order to deploy wireless and mobile learning on a larger and sustained basis, its champions must present their case in ways that address parity with other forms of provision and delivery in terms of institutional concerns such as:

- costs, funding, resourcing
- quality, validation, fitness-for-purpose
- stability and reliability
- monitoring and evaluation
- legal expectations

Within an institution, several different bodies may articulate these various concerns and determine progress on an issue as potentially pervasive and systemic as wireless and mobile learning. This is because it has attributes that impact on major areas of institutional policy such as IT infrastructure and procurement, staff development and training, teaching and learning practices, and quality management. The ‘ownership’ of the each of the relevant policies usually resides with a different institutional custodian, such as the IT, QA and HR departments and their activities interact and interlock in ways that can slow down innovation and improvement.

Technical support staff, within an institution’s Computer Centre or IT Department, are usually the custodians of institutional IT policy and when looking at wireless and mobile learning, are responsible for issues such as network security, hardware maintenance, interoperability, software support and IT procurement. All of these are potentially problematic, especially the issues of:
• network security and data protection
• interoperability with institutional software systems such as VLEs/MELEs, e-portfolios, portals, learning objects
• any pre-existing relationships, including procurement, with specific desktop PC systems, vendors and manufacturers, and their respective software systems
• support for staff members’ and students’ own devices.

A wider acceptance of support for student and staff members’ own devices is one way that institutions can reduce pressure on their own resources, and this is especially significant if institutions are to exploit the increasing ownership of handheld computers and smartphones. The reluctance of some technical staff to allow academic staff to install software on their ‘work’ machines is also problematic since it inhibits experimentation and crucially prevents synchronising and backing-up mobile devices.

Technical support staff usually have policy guidelines relating to mandatory, preferred and supported software systems. This policy is obviously derived from their work with desktop and laptop PCs and is potentially unhelpful if applied uncritically to mobile devices where the market-place is still evolving and the balance of the arguments about procurement is bound to be different.

Staff developers are the custodians of institutional HR policy and are faced with the training dimension of large-scale wireless and mobile learning. This may only be resourced if wireless and mobile learning forms part of institutional policy, or at least is not perceived to run counter to other existing policies. There are several models of how staff development could tackle issues of change in education. One model (Hall, 1974) looks at the need to address teachers’ and lecturers’ anxieties about change as well as addressing the need to up-skill.

If wireless and mobile learning are to become an established part of a course offered by an institution, then the institution’s quality assurance procedures, looking at fitness-for-purpose on behalf of students, will expect answers to questions such as:

• Are the proposed course and the student experience comparable to that of a face-to-face course?
• Are the proposed course and its delivery mechanisms fair to all of its students or are some disadvantaged?
• Are the assessment procedures proposed using mobile learning technologies as rigorous, fair and objective as conventional techniques?

These are clearly challenging issues for a new pedagogy to address, and wireless and mobile learning will require ‘second-generation’ pilots or large-scale trials across institutions and across subjects if its wider potential is to be realised.

Wireless and mobile learning is currently treated by QAA as part of Flexible
and Distance Learning in its general guidance to institutions. This guidance is relatively high-level and open to a considerable variety of interpretations at a local level. The view of wireless and mobile learning as fitting within Flexible and Distance Learning is potentially problematic for courses using wireless and mobile devices purely within the classroom. There is however increasing movement towards viewing wireless and mobile learning more holistically and looking at it in terms of a range of parameters including the balance of lone learning vs cohort learning, on-site learning vs off-site learning and face-to-face learning vs remote learning. At a local level, specific institutions ability to validate innovative wireless and mobile learning provision may depend on whether the institution is coming up to or coming away from some inspection or audit, and whether validation procedures are highly formalised and centralised or not.

Every university and college now has a teaching and learning strategy and this usually has an eLearning component. The institutional strategy articulates the roles and responsibilities that underpin the strategy and this will usually include high-level learning and teaching 'champions' responsible for carrying out and carrying forward learning and teaching in the institution. These champions are the custodians of institutional policy on teaching and learning and usually have a lead role in introducing and managing educational change across their institutions. This often involves mustering the resources, training and guidance (or indeed regulation) for embedding innovation and acting as the ‘gatekeepers’ to the wider use of wireless and mobile learning. It would usually be their responsibility to implement the practicalities of any institutional wireless and mobile learning policy.

Each of the case studies in (Kukulska-Hulme & Traxler, 2005) deals in part with these institutional issues and one in particular describes the introduction of institution-wide mobile learning.

One final and largely unresolved issue for more sustained wireless and mobile learning is the attitudes of students, potential students and teaching staff. Any initiative to introduce wireless and mobile learning can only successfully proceed if these attitudes have shaped the nature and extent of the initiative, in terms of the acceptability of the proposed devices, technologies, pedagogies and costs.

5.6 Strategic Overview – Possible Trends

The development of wireless and mobile learning in the post-16 sectors will take place in the context of various trends in the wider technical, social and commercial environment that will have considerable impact.

The leisure, retail, business and commercial markets will continue to drive mobile device design, marketing and pricing. This will mean that educational innovators will have to continue appropriating and adapting hardware and software technologies intended for other markets and other purposes.
It will also mean that many students, perhaps only the more affluent, will enter further and higher education already owning wireless and mobile devices. Educational institutions must accept and exploit this diversity of technologies, devices and connectivity, and use their own resources to maintain equity of access and use for less affluent students.

This will mean that institutions must be very flexible and responsive in working with a proliferation of platforms, systems and networks. There are several likely trends within the overall confusion and these may make the situation more manageable. Handheld computers (PDAs) are likely to continue to lose market share to smart-phones (with considerable connectivity and personal information management functionality), alongside a general migration of PDA functionality and potentiality into smart-phone devices and increased diversity and richness of connectivity. Handheld computers may also lose some market share to laptops and tablet PCs (with wireless connectivity and a widely recognised and accepted interface), though this is less likely to be significant amongst many potential students. The handheld computer market itself may see increased segmentation and fragmentation as manufacturers try to define and exploit progressively more specialised niches, whilst the power and diversity of peripherals (cameras, keyboards, location-sensors) will also continue to increase. There may also be growth in the ownership and use of USB memory sticks (to carry personal content and eventually some processing), personal music players (with personal information management and file space) and games machines. The steady increase in urban and campus connectivity will favour laptops at the expense of handheld computers and phones, especially if GPRS and its successors continue to be rolled out. It seems possible that PalmOS (and Palm) will continue to be under pressure from Microsoft as the dominant platform (and perhaps from Symbian in smartphones and the new iPhone 3G).

Community, further and higher education will begin to see raised expectations amongst their younger entrants as wireless and mobile learning become more widespread in schools and sixth-form colleges.

In line with general social trends there will be increasing but unsupported handheld computer use by academic staff and possibly even greater laptop usage (and home-working), reinforcing concerns about cost issues, the length of the working day, loss of privacy and stress, many of which have already been explored in relation to networked learning (Bacsich et al, 1999).

Institutions in further and higher education currently seem relatively cautious about exploiting wireless and mobile technologies in teaching, learning, assessment and administration and its champions must recognise and explore the issues that this review has raised. These include:

- usability (and this must include SENDA compliance)
- network security
- the diversity and fluidity of devices, platforms and systems
- lack of staff expertise
- procurement, maintenance, ownership issues.
One type of wireless and mobile technology use that is somehow different from most of the others is SMS texting based on mobile phones. It is different mainly because institutions unusually do not have to procure or maintain the hardware – mobile phones are a ubiquitous and inclusive technology - and need only pay for bulk messages. The usability and interface are poor and the purely pedagogic exploitation is challenging. SMS texting does however present a unique opportunity for institutions to improve retention, efficiency and contact. A few large-scale pilots are now beginning to take place.

Recommendations

We are seeing an increasing and informed diversity of learning, teaching and administration taking place on a range of wireless and mobile devices; we can also expect to see a continued improvement in the performance, usability and connectivity of mobile devices and a gradual understanding of the affordances of mobile learning in the wider context of technology supported learning. This section looks at strategies that can take wireless and mobile learning to a sustainable and substantial position in UK post-16 education.

The way forward for an institution will obviously depend on a wide range of local factors, including its students’ needs and preferences, its staff’s expertise and enthusiasm and the institution’s resources and organisation. There are however some tactics that will enhance the success of a wireless and mobile learning strategy:

- Projects will reward and support innovative lecturers, gain and publicise valuable early insights and give wireless and mobile learning positive local visibility.
- Exemplar content, lessons and courses across disciplines will give lecturers a sense of what they themselves could achieve; some of it should be ‘quick-and-dirty’ and invite imitation.
- High-level ‘buy-in’, managers seen using wireless and mobile devices, will increase credibility and status of wireless and mobile learning.
- Identification and exploration of potential revenue streams will enhance sustainability; some projects could specifically address this aspect of wireless and mobile learning.
- Recognition that mobile and mobile devices are ‘personal’ and encourage ‘ownership’ amongst lecturers – easy access to a range of mobile devices will develop familiarity, expertise and confidence.
- Reliable and robust technical support, infrastructure, network access and hardware will mean that lecturers can innovate – especially in front of ‘live’ classes - without risk.
- Standards introduced and developed only as experience accumulates, avoiding premature ‘lock-in’ to specific platforms or systems; the same is true of ways of measuring the progress and success of wireless and mobile learning.
Sustained, timely and accessible staff development that addresses lecturers’ pedagogic and technical worries; mixing ‘just-in-case’ with ‘just-in-time’.

Credible channels of evaluation, feedback and communication between students, lecturers and management will foster greater ‘ownership’ of the institutional strategy as it evolves.

Conclusion

From the above research we can see many possibilities in the area of mobile learning for students. We have looked at issues covering technology advances such as PDA’s, laptops, mobile phones, smart phones etc. We have also looked at an m-learning framework. These aspects will and can act as enablers in the future for successful.

But for mLearning to be commercially successful, education institutions will have to promote and continue research into the idea. We currently see at the present time that people can study across large distances. It will also depend on the continuing development of mobile devices, hardware and software across mobile networks.

Our main conclusions from the mLearning pedagogical study:

- Most mLearning studies have been small-scale and implemented in only one discipline. There is a major need for large scale implementations generalised across a range of disciplines and subject areas and across institutions.
- The great majority of mLearning experiments have dealt with a single pedagogical issue, e.g. enhancing classroom interactivity. They have also usually focused on a single technology. There is a lack of a consolidated body of knowledge to guide teachers in implementing mLearning, particularly in the university sector
- A major challenge yet to be overcome is the cost of mobile hardware, software, connection and usage charges. The lack of sustainability of many mLearning projects indicates that this may well be the major difficulty to implementing mLearning on a national scale. There is a great need for the investigation of low-cost solutions to implementing mLearning so that it can be sustainable.
- There has been a lack of focus on designated groups of students. The assumption has generally been that all student groups have similar mLearning needs. Where studies have examined mLearning with different populations, the results are difficult to interpret because of inconsistencies in discipline areas. A proper evaluation needs to be made of the effectiveness of mLearning with international different groups of learners.

We present the methodology for the future research in mLearning pedagogy:

...effectiveness
Possible research question: What is the effect of mobile learning systems on students’ and trainees’ achievements and attitudes?
...hypothesis
The students in the experimental group, who work under a newly designed and developed mobile learning system, will score significantly higher than the students in the control group, who study under traditional learning system on the items of a performance test. The students in the experimental group will outperform the students in the control group on scores of a reflective questionnaire’s items indicative for positive attitudes towards the way of learning.

...research design
The research design is pre-test, post-test with a control group. It is possible to compare the learning achievements and attitudes of students, randomly assigned to experimental and control groups. The experimental conditions include an elaborated mobile learning scenario. The control conditions include a variation of traditional learning systems. The experimental design will also control for the variation of subject matter content. Apart from learning achievements and attitudes, the research design will measure the effect of cognitive style of students and, if feasible, time and mental efforts.

...measurement instruments
Four measurement instruments could be used for the purposes of testing the effectiveness of the mobile learning scenario. These are: a pre-performance test, post-performance test, a reflective questionnaire and Kirton’s Adaption-Innovation Inventory for measuring problem solving cognitive styles. If needed mental effort will be measured with a special-purpose mental effort scale (Paas & Van Merriënboer, 1993).

We identify three main phases in such a research. We perform in this material the first phase – definition of the five components of the mLearning pedagogical framework. The research activities were based on existing models of exploitation of the potential of new technologies in pedagogy (eLearning), as well as the user requirements related to pedagogical framework; educational characteristics and existing pedagogical practices among the partnership and components of a ‘best-practice’ eLearning pedagogical experience. Future research will start with the implementation of the defined mLearning pedagogical framework in different contexts. In this phase there could be developed: mLearning scenarios according to the pointed issues of the investigation; evaluation methodology – evaluation plan, measurement instruments, research design; mLearning repository with technological framework, learning tools and courses content (implementation of existing mobile learning systems). During the third phase it could be conducted trials - usability and effectiveness testing.
References

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INTRODUCTION

This document contains a programme for the introduction of mobile learning into mainstream European education and training. It is directed at stakeholders and decision makers in European education and training including European Commission members, representatives of the 28 European Ministries of Education and Training (the members of the European Union plus Norway), stakeholders in the field of e-learning and decision makers in European schools, colleges and universities.

The document is in five parts:

- The role of mobile learning in European education
- The role of mobile learning in European education – an example
- The role of mobile learning in European distance education
- The role of mobile learning in European continuing education
- Using a performance-centred approach in mobile learning

The role of mobile learning in European education is divided into three sections. These are

- the rationale for mobile learning,
- a programme for mobile learning in European education
- the achievements of mobile learning today.

The rationale for mobile learning seeks to convince stakeholders and decision makers in European education of the value and importance of introducing mobile learning into their programmes. It uses statistical arguments, distance education research, audience research, financial and technological developments to emphasise that in the rapidly developing field of wireless technologies, education should not be left behind.

The programme for mobile learning in European education gives a four-stage approach to the introduction of mobile learning into schools, colleges and universities. The four stages are:

- use of mobile devices in educational administration,
- use of mobile learning for study help, use of mobile learning for course modules,
- use of mobile learning for location sensitive context sensitive education and training.

The achievements of mobile learning today shows the vibrancy of the field in a selection of international countries and in 28 European countries (the 27 members of the European Union plus Norway).
The role of mobile learning in European education – an example gives an illustration of the incorporation of mobile learning into mainstream education and training at the Corvinus University of Budapest, Hungary. It deals with the strategies, courseware, pedagogy and mobile Learning Management system (CooSpace) used in the university.

The role of mobile learning in continuing education studies the role of mobile learning in adult education, continuing education and in professional education.

The role of mobile learning in European distance education, illustrates the place of mobile learning in four case studies of leading European distance education systems: the Open University of the United Kingdom, the FernUniversität in Hagen, Germany, NKI, Bekkestua, Norway and Dirksen Opleidigen from the Netherlands.

Using a performance-centred approach in mobile learning details pedagogical and technological research undertaken at the University of Plovdiv in which a mobile version of the university's Learning Management System, Dipsiel, was adapted for mobile learning to produce the mobile Dipsiel system.
PART 1

THE ROLE OF MOBILE LEARNING IN EUROPEAN EDUCATION

1. RATIONALE

The statistics

Never in the history of the use of technology in education has there been a technology as available to citizens as mobile telephony. The statistics are stunning. In July 2005 Ericsson announced that the number of mobile devices in the world had topped 2 billion for the first time. They forecast ownership of 3 billion mobile phones as early as 2010. By May 2007 the figure had risen to 2.5 billion. On 1 February 2008 Carl-Henric Svanberg, the CEO of Ericsson announced: “There are now 3.300.000.000 mobile subscriptions in the world – and every month an additional 50 million people in the world start using their first mobile phone. This figure of 3.3 billion mobile subscriptions far outstrips all previous forecasts.” All this is for a world population of 6.5 billion.

The dependence of citizens today on mobile telephony in every country of the world is demonstrated by a 2007 study carried by the London School of Economics for the United Kingdom company, Carphone Warehouse. The major findings are striking and surprising:

- One in three people would not give up their mobile phone for a million pounds or more, with women leading the way on those most likely to refuse.
- 76% of people believe it is now a social requirement to have a mobile phone.
- 85% of people think having a mobile phone is vital to maintaining their quality of life.
- One in five 16-24 year olds think having a mobile phone increases their quality of life.
- Most young adults who took part in the ethnographic experiment felt mobile phones were not just a tool, but a critical social lifeline for feeling part of a friendship group.
- Most of 16-24 year olds would rather give up alcohol, chocolate, sex, tea or coffee than live without their mobile phone for a month.

The distance education background

There is a finding of distance education research which states that ‘it is not technologies with inherent pedagogical characteristics which succeed in distance education, but technologies that are generally available to citizens’.

A typical example of this finding was the 12” laser discs of the 1990s. They had excellent pedagogical possibilities, exceptional courseware was developed for them especially for ESL (English as a Second Language), but they failed because there were not enough of them owned by citizens.

If this research finding is true, then there never was a technology more suitable for distance education than mobile telephony, as the statistics just presented show.

All over the world in rich countries and poor countries, in developed economies and underdeveloped ones, a mobile phone is a prized possession. The country with the most mobile phones is China.

Financial considerations

It is known that all the 27 Ministries of Education of the European Union countries spend millions of euros annually on the provision of educational technology for their schools, colleges and universities.

For the first time in history a technology is available for learning that will cost the Ministries of Education nothing, because the students own the technology to be used.

Technology developments

The field of wireless technologies is developing with great rapidity. Most of the developments contribute to the greater feasibility of mobile learning and to the richness of the courseware that can be developed for mobile learning.

The development of 3G, unlike 2G, allows subscribers to use multiple services simultaneously for example, if one is using the internet on a 2G phone and received an incoming voice call, one would have to stop the internet session to take the call. Once the call ends, one has to set up a new internet connection.

This is not the case in 3G where speech, video, internet and email can all be running on the same device at the same time without one service interrupting another.

As well as this greater service flexibility, WCDMA also allows a wider range of services to be offered due to the higher data rates (up to 2Mbps in theory).

High Speed Packet Access (HSPA) has facilitated the introduction of mobile broadband which has been the largest driver in the 3G market recently. The
increase in speed with the reduced delay greatly improves services such as web browsing, data transfer, audio/video streaming and also allows the subscriber to access the internet wherever/whenever they like.

All this has greatly facilitated the development of mobile learning and contributed to the richness and complexity of courseware on mobile devices.

The next move is to 4G. In the future, low cost, high speed data will drive forward the fourth generation (4G) as short-range communication emerges. Service and application ubiquity, with a high degree of personalization and synchronization between various user appliances, will be another driver.

The evolution from 3G to 4G will be driven by services that offer better quality (video and sound) thanks to greater bandwidth, more sophistication in the association of a large quantity of information, and improved personalization. This will lead to mobile learning achieving nearly all that e-learning can do today, without the need of carrying around a desktop or laptop computer (Nix 2008)

The mobile handset evolution
Embracing and embedding feature after feature

Credit cards
Tickets, Keys
Pocket TV
Video camera
Game console
GPS, Navigation
Digital camera
Music player
Memory stick
Portable radio
Security, Alarm
Calendar, Calculator
Fixed phone, PDA

"Always with you"

In January 2007 there were an estimated 2.7 billion mobile handsets in use around the world, of which 1 billion were sold during 2006. This is more than three times the number of PCs, and roughly double the number of fixed landlines in use. And most of these handsets have the processing power of yesteryear’s PCs.” - Berg Insight (June 2007)

We are moving towards an all IP world. In terms of telecoms networks, soon the entire network will be IP based (Service, Core and Access) allowing full integration with computer networks and improving the range of services available to subscribers e.g. voice over IP, IPTV.

Rich in multimedia IMS (IP Multimedia Subsystem) is seen as a key strategic area in terms of mobile network evolution. IMS will allow for a new range of services. The push in the networks to move to IP is being driven by the cost of
transmission lines. With the introduction of IP transport over Ethernet the cost of leasing/maintaining transmission will be reduced in comparison to copper with the advantage of providing greater bandwidth for content rich services.

Again the benefits for mobile learning of these technological developments will be great.

Importance

The fields of wireless technologies and of mobile telephony are moving ahead with amazing rapidity. Today the industry of providing news feeds and sports feeds to mobile phones is commonplace in most countries of the world. The techniques of sending these feeds to mobile devices can be used to provide mobile learning. It is crucial that education and training are not left behind by these developments.

Europe holds the lead in the development of wireless technologies; it is important that it should hold the lead in the provision of mobile learning too. Exciting developments in Japan, in South Africa, in Taiwan, and soon in Korea and China, pose serious challenges to Europe’s lead in mobile learning.

2. THE PROGRAMME

This programme for the role of mobile learning in European education is on four levels:

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Level 1 Use of Mobile Devices in Educational Administration

The first level of mobile learning recommended is the use of mobile devices in educational administration. Illustrations of this usage are given from school and college administration, usage in the combating of drop-out and use in distance education.

Administration

All students enrolled in all higher and further education institutions today have a frequent need for information from their institutions about timetable changes, assessment deadlines, feedback from tutors and other urgent administrative details. Equally, all higher and further education institutions today have a frequent need to provide information to their students about timetable changes, assessment deadlines, feedback from tutors and other urgent administrative details. Although nearly all of these students carry a sophisticated communications device which they use constantly in all walks of life, they do not always use it in their education or training programme?
If a lecture, or similar activity, has to be cancelled at short notice the university or college can communicate with the student body concerned by the postal services or email. These are not always effective means of communication so many of the students will turn up for the cancelled lecture and be inconvenienced. The institution’s administration may come in for criticism.

However, if a lecture, or similar activity, has to be cancelled at short notice, the university or college communicates with the student body concerned by SMS (Short Messaging System), all of the students will receive and read the message, no-one will turn up, no-one will be inconvenienced and the institution’s administration will have been successful. SMS messages can be sent in this way either to the whole student body, or a faculty, or a department or a class grouping.

Examples of usage of mobile telephony in educational administration are:

- Cancellation of a lecture
- Message from headmaster to parents: ‘Your son/daughter will be late home from school today as he/she has received a detention’
- Bringing forward the date of an examination
- Change of deadlines for enrolment
- Deadline for the presentation of an assignment.

**Drop-out**

Government decisions in a number of European countries have heightened the importance of the reduction of the drop out rate in universities and colleges. In some instances subsidies can be reduced if the drop-out rate is not reduced. The prevention of avoidable drop-outs has been an intractable problem in higher education for years and often costly methods, like increased counselling and mentoring, have been introduced to combat the phenomenon.

The University of Ulster in Northern Ireland has had success in the use of SMS messaging for the reduction of student drop-out. It found that sending SMS messages to students who have been identified as being at risk, has been a successful approach for keeping students in the system and for maintaining the government *per capita* grant.

The University of Ulster sent out messages to students of the type ‘Sorry, we missed you today’. The university initially feared that this might be intrusive. On the contrary the students did not find it intrusive at all. The students liked it and wanted the university to expand the service to other areas – like assignment deadlines.

The University considers that speed is essential in dealing with drop-outs: ‘Two weeks and they are gone’. Other methods of dealing with drop-outs have a lead time of several weeks. The University regards drop-outs reduction as a duty of care. They feel that a frequent cause of drop-outs is that ‘Nobody cares’. Groups of 4,500 students can be alienating. The personal touch of a message on a mobile phone can be an answer (Keegan 2006).
Distance Education

In its faculty of education in 2002, the University of Pretoria, South Africa, had hundreds of students enrolled in the equivalent of a Higher Diploma in Education by distance education. None of these students had email or could avail of e-learning but all had a mobile phone. They were all full-time teachers employed in rural schools.

The university used mobile phones very successfully in their paper-based distance education programmes for university administration, achieving almost immediate communication by SMS messaging in an area where email was unavailable and post took 5 to 15 days.

The profile of these students in 2002 was as follows:
- The majority live in rural areas
- 100% are full-time employees (teaching)
- 0.4% had access to e-mail
- 99.4% had a mobile phone

Mobile phone support to these rural distance learning students entailed sending bulk, pre-planned SMSs to:
- all students;
- students of a specific programme for general administrative support as well as motivational support;
- specific groups of students extracted from the data-base for specific administrative support (customised group SMS); and
- small group or individual SMSs to specific students extracted from the data-base on an individual basis for specific administrative support.

The advantages and successes were significant:
- In response to a reminder for registration for contact sessions, 58% of the learners registered before the closing date compared to the normal expected percentage of below 40%.
- In response to a reminder of the contact session dates, 95% of the learners that registered for the contact sessions attended.
- Learners responded en masse and almost immediately to information provided in SMS-messages.

If it can be done successfully in rural Africa it can certainly be done successfully in Europe (Brown 2005).

Level 2 Use of Mobile Learning for Study Help

Once a school, college or university has instituted the use of mobile devices in its administration, the next stage is to use mobile learning for academic purposes. In the first instance this can be for study help. Typically these are four to five screen communications from the institution to the student focusing on course summaries, help with a difficult assignment, assistance with a part of a course that has given difficulties to students in the past, notification of
enrolment or assignment deadlines, tutorial advice or multiple choice questions.

- Academic support for learners via SMS, MMS and WAP:
  - communication and interaction from and with educational institution
  - communication and interaction with peer learners and study groups
  - browsing e-learning course material
  - downloading study guides/manuals
  - receive tutorial letters
  - complete multiple choice assessment with immediate feedback
  - send template based multimedia messages to institution (templates designed and provided by institution)
  - generic feedback on assignments and examinations
  - motivational messages
  - tutor services

- Administrative support via SMS, MMS, WAP and EPSS, integrated with the Internet:
  - downloading of material (sections of learning materials, assignments, letters, etc.)
  - access to institutions M-portal on the web
  - access to examination and test marks via mobile service number or M-portal
  - access to financial statements and registration data via mobile service number

- Daily tips

**Level 3 Use of Mobile Learning for Course Modules**

Once the institution has completed the introduction of five to six screen study helps on mobile devices, it is time to consider the provision of full course modules on mobile devices or via podcasting. The goal is that mobile learning should enter into mainstream education and training and no longer rank as a project in the institution. For acceptance into the mainstream four criteria are required: accreditation, curriculum, assessment and fee-paying.

**Accreditation**

The enrolment of mobile learning students into accredited courses is a goal of mobile learning course development. Thus the mobile learning module or part of a module needs to be accredited in the same way as the other academic offerings of the institution. If a course is not presented as accredited in the prospectus of the institution, it remains at the level of a research project and has the fragility of project status.
Curriculum

It is a goal of the field of mobile learning that mobile learning courseware should be presented in the curriculum of the institution with the same procedures as are applied to the presentation of face-to-face and e-learning courses. It is important that mobile learning courseware, or modules of courseware which have mobile learning components, should form part of courses that are presented in the same way as the other courses of the institution. This has been implemented successfully in Corvinus University of Budapest.

Assessment

It is a goal of the field of mobile learning that mobile learning courseware should be assessed with the same rigour as is applied to the assessment of face-to-face and e-learning courses. It is important that mobile learning courseware, or modules of courseware which have mobile learning components, should form part of courses that are assessed in the same way as the other courses of the institution.

If this does not occur, mobile learning will not be incorporated into the mainstream of education and training provision. It will remain a project with all the fragility of project status.

Parallels with the field of distance education, of which mobile learning forms a subsection, are relevant here. Distance education had the advantage of using the same methods of assessment as were current in face-to-face education at the time. These were either essay-type assessments, or written answers to questions set by the institution and its representatives.

The history of assessment in eLearning was quite different. eLearning was, from the start, characterised by a strong corporate dimension and by the use of quizzing, and multiple choice questioning for assessment purposes.

Fee-paying

The enrolment of mobile learning students into fee-paying courses is also a goal of mobile learning course development.

Clearly these observations apply only to courseware in countries in which fees are payable for further and higher education programmes.

It is a goal for the field of mobile learning to emerge from its present project status and take its place as an official form of education and training provision, as the fields of distance education and e-learning have done before it. A major stage towards this official status is the listing of the course for paid student enrolment. The dangers for the field of mobile learning of not achieving this official status are that it remains at project level, the preoccupation of a professor or staff member working on a research project in some small area or department of a college or university. The undertaking remains peripheral
to the official procedures of the college or university, and of its faculty or department structure.

The characteristics of projects are well known. They tend to collapse when the project funding is withdrawn. There is no continuity of results once the project has been completed. The project grouping tends to be dispersed and to focus on new undertakings. The expertise developed within the project group tends to be dissipated and the research gains are not consolidated.

**Mobile learning course activities**

Laurillard (2007), formerly Pro-Vice Chancellor of the Open University of the United Kingdom and today at the University of London presents the use of mobile learning as follows. Laurillard uses italics to highlight the specific contribution of mobile learning.

A typical m-learning activity could build in more opportunities for digitally-facilitated site-specific activities, and for ownership and control over what the learners do (shown in italics):

- teacher introduces the work of the artists; provides extracts of the catalogue linked to key paintings for students to read in advance and download to their mobile devices; answers questions

- teacher provides a guide for students to work in pairs in the gallery with digital codes for each painting guiding them through the key paintings and the relations between them, including instructions to identify features in particular paintings, upload their answers and check against the teacher’s model answer, set quiz questions to challenge other pairs, answer challenges from other pairs, record these and their observations on each painting, uploading these to a shared website, and take notes to bring back to class

- students work in pairs in the gallery, using the guide, making notes, checking their observations against the teacher’s, setting and answering challenges with other students, recording and uploading their ideas and observations, with the teacher moving between them

- in the next class discussion, students are asked to report on what they noticed and the notes they took, using the whiteboard to display their records and notes from the gallery

- the teacher ends the discussion by summarising their comments in terms of the intended thesis, by means of an edited version of the students’ outputs collected in the form of a collaborative digital catalogue of the exhibition, and made available on the school website.
Level 4 Use of Mobile Learning for Context Sensitive Location Based Education and Training

Once an institution has successfully developed mobile learning course modules it is time to consider the development of courseware with location based and context sensitive attributes. Here one enters an area in which mobile learning is supreme and for which mobile telephony is particularly suited. The provision of location based and context sensitive courseware is a characteristic that mobile learning does better than face-to-face education or distance education or e-learning.

The profile of the typical mobile device is changing rapidly. It is estimated by 2010 that the number of people using mobile broadband connections will have increased to over half a billion. This access is being made on all types of mobile devices: mobile phones, media players, handheld games consoles, ultra portable PCs, etc. Already one is seeing a great deal of convergence in the marketplace; while it is common to see people carrying both a mobile phone and a media player, such as an iPod, these devices are merging, with mobile phones offering gigabytes of storage for audio and video. Devices running Windows Mobile and Symbian have many of the features of laptops or desktop computers and are now being used to access the net at broadband speeds.

As a result it is now possible to envisage an audience for mobile learning content which is media rich, collaborative and always available to the user. Using established technologies such as GPS and SCORM, and developing for newer technologies such as RFID (Radio Frequency Identification) and Mobile Positioning, training content can be developed for both context sensitive and location based delivery. Context sensitive education and training refers to training material which is directly relevant to the training situation that the learner finds themselves in. Location based education and training refers to material which is directly relevant to the location in which the students find themselves.

Because mobile devices can be used almost anywhere, they are perfect platforms for situated learning activities, where real life is used to provide stimuli and activity for learning. An example of a situated learning activity would be studying art in a gallery instead of from an online photograph or a text book. In this scenario, the learner would be pushed information about the specific artwork they are standing in front of which would be determined by the mobile network. Handheld devices can be used in public and social settings where larger devices would be intrusive and seem out of place. Using a small device like an audio tour guide or an iPod or a mobile phone web browser is an obvious use of mobile technology; typing on a laptop computer in the same environment is not as acceptable or practical.

Current handheld devices are capable of the processing power, information storage, and data connection speeds exceeding that older personal computers - but are not reliant on power sockets or CAT-5 cables. They are capable of all of the same kinds of learning tasks: peer-to-peer sharing, ad-
hoc networking, wireless internet access, discussion boards, chat, voice calling, video messaging, and resource creation and editing. They can support free and open source software, all the way from their Operating System, through to their applications, and even support and integrate with Web 2.0 tools.

The IP Multimedia Subsystem (IMS) standard defines a generic architecture for offering Voice over IP (VoIP) and multimedia services. It is an internationally recognized standard, specified by the Third Generation Partnership Project (3GPP/3GPP2) and embraced by other standards bodies including ETSI/TISPAN. The standard supports multiple access types including GSM, WCDMA, CDMA2000, wireline broadband access and WLAN.

IMS-based services enable communication through various media, such as voice, text, pictures and video, or a combination of them. Adapted to each individual’s preference IMS enables a consistent experience across multiple access technologies, user devices and geographic locations for business or private use. It also allows users to better indicate their accessibility – or their ‘presence’ – so they can control how, where, when and by whom they can be reached.

3. THE ACHIEVEMENTS OF MOBILE LEARNING TODAY

The achievements of mobile learning today – international

The project ‘The role of mobile learning in European education’ has completed two major studies of mobile learning.

The first study is an international analysis of the achievements of mobile learning worldwide. It is 180 pages in length and deals with Australia, Canada, India, Japan, Republic of Korea, South Africa, Taiwan and the United States of America.

Much of the data is unique, little known and not available elsewhere. Extensive bibliographies are included of mobile learning in Japan, Korea, Taiwan and China which will be of value to other researchers in the field.

The study shows that Japan, Taiwan and South Africa are world leaders in the field of mobile learning and that both Korea and China have great potential to also become major players. Considerable activity has also been documented in Australia, Canada, India and the United States of America.

The full text of the report is available on the project website Http://www.ericsson.com/socrates2006.

The goals of the study are:

- To show that mobile learning is developing rapidly in many parts of the world
• To bring to a wider audience the little-known achievements in mobile learning of a range of countries
• To convince the European Commission and the 27 European Union Ministries of Education that mobile learning is a vibrant field which should be supported
• To emphasise that European leadership in wireless technologies needs to be extended to mobile learning as well.

The achievements of mobile learning today – European.

The second study is an analysis of the achievements of mobile learning in 28 European countries today (the 27 members of the European Union and Norway). It is 300 pages in length. Again much of the data is unique, little known and not available elsewhere.

The results of the data collected allow one to rank the European countries in 4 levels with respect to their achievements in mobile learning.

At level 1, there can be no doubt that the United Kingdom is the leading provider. The United Kingdom has at least 4 areas of provision: primary and secondary schools, universities, government departments and corporate providers.

Provision at primary and secondary school level is vibrant. This work began with Professor Mike Sharples, then of the University of Birmingham, working with primary school children who recorded and analysed data on PDAs. Hundreds of UK primary and secondary schools attended the Handheld Learning Conference in London in October 2007, and this gave the conference a noticeable school-level focus.

Many UK universities are active in the field. Leaders are the University of Nottingham (Prof Sharples), the Open University which has a mobile learning research group that produced the major book in the field, London Metropolitan University, which has produced extensive mobile learning courseware and the University of Bristol (Dr Wishart) which has produced extensive mobile learning materials for teacher training.

The government agency LSDA led a major EU project to produce literacy and numeracy mobile learning materials for disaffected youths and its successor LSN is again involved in a major project, MoLeNET. BECTA has also worked extensively in mobile learning.

There are a wide range of British companies involved either in the production of mobile learning systems or of mobile learning courseware to run on these systems. These include Tribal CTAD, Handheld Learning, ConnectED, Learning in Hand.

1000 British delegates are expected at the Handheld Learning conference to be held in London in October 2008. If each of these delegates has been
involved in the provision of mobile learning in some way, then mobile learning in the UK is thriving indeed.

Level 2 consists of countries in which there has been mobile learning activity mainly in the form of participation in European Commission funded projects. These countries are: Austria, Bulgaria (notably the University of Plovdiv), Cyprus, Czech Republic, Denmark, Finland, Hungary (notably Corvinus University of Budapest), Ireland (notably Ericsson Education Ireland), Italy (many university and government research centre projects), Netherlands, Norway (notably NKI), Portugal, Slovakia, Slovenia, Spain, Sweden.

Level 3 countries are making their first fragile steps in the field of mobile learning. These countries are: Estonia, France, Greece, Latvia, Lithuania, Malta and Poland.

Level 4 countries are those in which little or no activity in mobile learning has been documented. These countries are Belgium, Luxembourg and Romania.

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INTRODUCTION

The Corvinus University of Budapest in Hungary is an excellent example of the incorporation of mobile learning into mainstream European education and training.

Competition between e-learning solutions is increasing at an alarming rate, while changes of the surrounding environment and the demands of both students and the labour market are frequent and substantial.

Vendors must meet these requirements in order to successfully compete both on national and international level. Moreover these factors put pressure on higher education institutions to turn towards the development and application of such innovative and modern technologies that enable students to easily access, understand and apply complex curricula and other teaching materials.

MOBILE LEARNING AT THE CORVINUS UNIVERSITY OF BUDAPEST

Being mobile while studying is not a new idea. It has been incorporated into teaching activities and official curricula a long time ago in the form of field trips and on-the-spot training. The appearance of mobile technology in education in the mid 1990s has extended the scope of teaching and led us into a new world of education.

Mobility in learning, supported by the latest information and communication technologies (ICT), has become an essential need of both the new generations of students and educational institutions (Naismith, Corlett, 2006.). In order to suit all the requirements it is not enough to simply ‘mobilize’ the ordinary learning environments (Walker, 2006; Keegan, 2005), but conflicts of informal learning and Face-to-Face (F2F) education also have to be eliminated (Sharples, 2006). Integration of mobile devices into education also fosters the inclusion of innovative educational practices. (Milard, 2006; Hoppe, 2006).

At the same time the above mentioned transition has its institutional limitations. In traditional educational institutions, like in the Corvinus University of Budapest, learning technology should be an integral part of knowledge transfer between students and lecturers, but it can not be the only platform of teaching.

However it is essential to keep up with students’ demand – which forces institutions to involve technology more and more in their everyday teaching.
activities, enabling students to be flexible in their learning – and construct F2F based learning platforms, which provide elasticity in course content development and delivery. To meet the challenges, emerging from combining ICT enhanced learning and traditional classroom education, a blended service framework has been elaborated. This service portfolio designed by the educators of Corvinus University of Budapest (Kismihok, 2007) is described in Figure 1.

The core element of the portfolio is F2F education. The scope of curricula taught in the training programs is represented by the recently developed educational ontology (Vas, 2007), which is going to be the domain of future content development as well. On top of traditional classroom teaching a Virtual Learning Environment (VLE) supports individual learning, enabling the use of different independent learning styles.

A Hungarian Learning Management System (LMS - CooSpace) provides authentication and other community services related to course organization. Further important service-modules, like adaptive testing, are connected to this platform as well. Mobile learning infrastructure, as an enhancement of the VLE, adds flexibility to the system, where individual learners are not bound to a certain location or time anymore, however, the content is still connected to the traditional lectures and seminars.

As Figure 2 indicates, there are three different aspects of Mobile Learning that is being covered at Corvinus University of Budapest.
Learning environment
To exploit the advances of mobile technology it is indispensable to transform the traditional learning environments into mobilized learning spaces otherwise users can’t benefit from mobility. Challenges of limited resources of mobile devices have to be tackled and fitted to the long-established campus-workstation based services. In the Corvinus case, the mobilized infrastructure provides an access point to selected services using a mobile phone.

Collaboration
One of the main driving factors of mobility is collaboration. Fostering interaction between the stakeholders of learning processes is a key benefit that has to be supported with reliable services (Keegan, 2005). Collaborative functions like forums, notice boards and messaging services are available in Corvinus’s system. An example of a mobile forum is visible on Figure 3.

Figure 2: Aspects of Mobile Learning at the Corvinus University of Budapest
Content – pedagogy

When content is created for the mobile learner, the creator should establish learning scenarios that can be guidelines for content mobilization. On the one hand lecturers want their lecture notes available for their students anytime, anywhere. On the other hand there are some applications (quizzes, games or evaluations), which are easy and fun to use on a mobile phone. At the same time being a mobile learner also means that the student uses content, transferred by the above mentioned means of educational infrastructure, in context. Getting learning content on the right spot at the right time makes formal and informal learning mobile.

In Figure 4, four examples are given for different types of content available in the system. From left to right the first two screens show a context sensitive course, called “Urban Architecture”. The topic covers the history of door-making in Budapest. Students walk around in a certain district of the city and investigate buildings themselves. In the third picture the outlook of a test module can be seen. The last one shows the general outlook of the mobile learning environment for a given course with the available learning content under “Mobil tananyag”, the additional documents under “Dokumentumok” and the available course related forums under “Fórum neve”.
Learning Infrastructure
A learning infrastructure had to be developed that can actively support the whole learning cycle, independently from its form (e.g. workstation- or mobile phone-based learning). The user logs into the Student Administration system through a mLearning Management System (Coospace), where the given teaching materials are implemented, and accessible for studying. The mLMS is connected to the ontology-driven environment. This environment consists of the Educational Ontology and the Repository that are the two major pillars of the whole solution and the Adaptive Testing Engine as well. Finally some external modules – offering extra services – will be discussed that are also connected to the mLMS. Figure 5 depicts how the system elements are connected to each other to provide a comprehensive solution.

Process and Principles of Content Development
The development of the curriculum content begins with the construction of the appropriate ontology. Ontology and domain experts determine the structure and concepts of the domain of the curriculum and with the chosen editor tool the ontology is built.

As the ontology is finalized, domain experts extend the bare structure with textual and multimedia content elements. Content elements reside in the Repository. Domain experts can search the repository for already existing content or create new elements if needed. Selected content elements are attached to the appropriate nodes of the ontology. This process is basically the establishment of assignments or relationships between ontology nodes and content elements.

The content developer has to design the curriculum material carefully to maintain a balance between the core and illustration material. Core material is related strongly to the ontology concepts, building the most important and
basic elements of the curriculum, while the purpose of illustration elements is to help understanding the material. Core elements are usually textual ones, while illustration material can involve a large variety of content elements, like pictures or video clips.

After finishing the content assignment, the Testbank has to be filled. The domain expert can use the Test Item Editor to edit questions and assign them to the appropriate node of the ontology.

The result of this process is the finished ontology structure with attached content elements and questions. The last phase of content development is the packaging, meaning the creation of standard SCORM packages by extracting the structure of the ontology into a curriculum structure and storing the appropriate content elements together according to the standard. Another package is also created containing the Testbank and the extracted ontology structure. The SCORM content package is deployed into the Learning Management System and the test package is deployed in the Adaptive Testing Engine.

**External Modules**

Before the recent ontology-based content development, several electronic content packages had already been created, which are still in use. These materials were mainly accessible from traditional VLEs, and only some of them were available in formats suitable for use with mobile devices. The format and the type of these items are varying. These materials, together with other explanatory applications, are connected to the mLMS as external modules and available for download for the latest mobile phones. Mainly these contents were produced in the following formats

- MS Power Point Slideshow
- Adobe PDF
- HTML format – also accessible for some WAP browsers
- FLASH format

With all these formats the Corvinus staff was capable of delivering the learning content via the following ways: Face to Face education (PPT), eLearning applications (Flash, PDF) and Mobile devices (HTML).

When designing the images in the content the author always had to consider the minimum screen size resolution. These materials were optimized for 132*176 pixels, which is considered as being a regular mobile-phone screen size.
**Mobilized content delivery system (user perspective)**

The content must be uploaded to the mLMS to be available for students. Within the mLMS a Mobile Learning Space has been created for the course participants, where all teaching materials are stored.

Students who log into the system from a mobile phone using the mobile interface of the LMS, can access and read the content, which is in the Mobile Learning Space. They can also download documents, which are not assigned to the Mobile Learning Space, but probably can not open and read all these documents. The limitation is the handset, however this might be possible with some of the latest handheld devices. All materials are also accessible via the normal internet interface. PDAs, smartphones with Wireless LAN function are capable to enter the LMS this way.

In the case of using a WAP browser of a mobile phone, it is probable that the browser is not capable of accessing the website. To avoid this problem it is recommended that students use the Opera Mini browser, which is a free internet browser application for a wide range of mobile phones. This Java based browser runs on almost all commonly used devices. The downloading instructions for the Opera browser were provided through the mLMS as well.

**The Learning Infrastructure from the Mobile Perspective**

Although mobile learning still has technological limitations – like small screen or bandwidth problems, etc. – the most burning questions that require solution are mainly non-technological. The pace of life is accelerating and traditional processes are becoming more and more fragmented. In many cases there is no time for traditional, strictly scheduled education anymore, where it can easily happen that individuals do not get any feedback concerning their knowledge for months.

Today, employees are expected to be open to acquiring new skills, attitudes and knowledge at any time that require supporting technology. The above discussed learning infrastructure adapts to this changing environment by ensuring availability anywhere, at any time. Moreover, feedback is provided immediately. After self-training, users can access the adaptive knowledge testing environment that provides instant evaluation of their present knowledge and suggestions concerning what to study next.

**Future plans**

The system, as described above, consists of various components, moreover the majority of these components are already existing software, integration is a main issue. For this purpose, a Service Oriented Architecture was selected as the state-of-the-art approach to application integration. (He, 2003) Naturally, as the Service Oriented Architecture is only an approach, interface standards describing the integration have to be declared. For this requirement, Web Services has been selected.
This integration approach enables an enormous degree of freedom in deploying the system or replacing elements with already existing components. During the development of the system, developers have chosen an already existing offline tool (a desktop application) for packaging. Even this standalone application can use the resources of the online-accessible Repository to build packages. Existing systems can also be fit together by developing appropriate interfaces. This approach was used to attach the Adaptive Testing Engine to the Learning Management System.

The Service Oriented Architecture approach also enables the deployment of the system in already existing corporate of educational environments. Any component can be replaced that has already existing alternatives at the organization, or it can even be attached to an Enterprise Service Bus by using appropriate adaptors. This provides flexibility and great opportunities to extend our investigation to the corporate sector.

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PART 3

THE ROLE OF MOBILE LEARNING IN EUROPEAN DISTANCE EDUCATION

INTRODUCTION

It is not surprising that a number of distance teaching institutions have been interested in researching possibilities of introducing and integrating mobile learning solutions into the distance education system. Distance education institutions may be divided into four broad categories according to type of institution (some examples are given below):

Consortia, such as:
Bavarian Virtual University, Germany: www.vhb.org
Norwegian Networked University: http://www.nvu.no/

Distance education universities, such as:
The British Open University in UK: http://www.open.ac.uk/
The Dutch Open Universiteit: http://www.ou.nl/
La Universitat Oberta de Catalunya: http://www.uoc.edu/portal/catala/
Universidad Nacional de Educacion a Distancia – UNED, Spain: http://www.uned.es
Fernüniversität, Germany: http://www.fernuni-hagen.de/

Distance education institutions, such as:
NKI (Norwegian Knowledge Institute, Norway: http://www.nki.no/in_english.xsql
NKS Nettstudier, Norway: http://www.nks.no/

Distance education departments in universities, educational companies or schools, such as:
BI Nettstudier, Norway: http://www.bi.no/Content/StartPageLocal__56116.aspx
Dirksen Opleidingen: http://www.dirksen.nl/

Mobile learning as developed by distance teaching institutions has been concerned with mainly three types of developments. The information presented below is adapted from the research carried out on mobile learning generally in Europe (Carvalho et al. 2008).

Firstly, as demonstrated by NKI, mobile learning has been introduced on a large scale with a general aim of increasing quality and access by supplying courseware/learning materials to be accessed by handheld devices and also develop the learning management system to include handheld devices for communication between students and between students and tutors/administration. The main aim has been to enhance flexibility of teaching and learning based on the assumption that e-learning requiring access to PC
and Internet in fact reduced the flexibility of students being able to learn independent of time and place that was the hallmark of previous generations of distance education, including correspondence education.

Secondly, mobile learning solutions have been introduced to increase quality by supplying some teaching materials on handheld devices, so that students may use their mobile phones or PDAs for tests, quizzes, revision before exams or for studying specific materials in spare time when PC or Internet connection is not available. Such uses have been demonstrated by e.g. the German Fernuniversität.

Thirdly, mobile learning solutions have been used by some institutions for mainly administrative purposes. E.g. Dirksen Opleidingen in the Netherlands used SMS messages for quick information to their students and also used SMS questions with answers for exam preparations for their students.

CASE STUDIES OF MOBILE LEARNING IN EUROPEAN DISTANCE EDUCATION

1. Mobile Learning at the Open University of the United Kingdom

As probably the leading distance education university in the world it is no surprise that the Open University is researching issues around mobile learning both connected to its own services and as an area of educational research in itself. Below is a summary of mobile learning projects prepared by Dr Agnes Kukulska-Hulme at the Institute of Educational Technology (Keegan 2008)

*Mobile Learner Support in the Virtual Learning Environment*

The Open University is developing a virtual learning environment to provide an integrated, high quality online learning experience for students across the full range of subject areas and curriculum. This development includes work on mobile learning, for users with no fixed point of access, those who synchronise information to mobile devices for offline use, and those who connect ‘on-the-go’. The project is promoting a device-independent approach and has a broad scope of activity including podcasting, RSS news feeds, text-based announcements by SMS, instant messaging, m-assessment, mobile course content, and social and user-generated content on-the-move. Further information: [http://conclave.open.ac.uk/mLearn/](http://conclave.open.ac.uk/mLearn/)

*Projects in the OU Centres for Excellence in Teaching and Learning*

The Open CETL is made up of four centres and provides insights into delivery of effective life-long learning at scale and free from constraints of time and place. Several mobile learning projects are supported, e.g.:

In the Centre for Open Learning of Mathematics, Science, Computing and Technology (COLMSCT):
• A feasibility study of the use of novel portable technologies for the delivery and studying of course material.
• An investigation of the use of mobile technologies to support students’ learning.
• A critical review of the use of enabling technologies for commentary on on-line assessment and on-line tutorials, with reference to both technical aptitude and motivation.

In the Centre for Practice-Based Professional Learning (PBPL):
• Investigating science teachers’ use of mobile devices in workplace settings.
• Using PDAs for staff development: giving academic and support staff the opportunity to experience handheld learning in the context of their personal and professional development.
• Harnessing technology to enhance teaching and learning experiences at a language learning Residential School. Further information on the work of Open CETL: http://www.open.ac.uk/opencetl/

Open University tutors investigating options for using mobile devices and techniques to support students

A project has been set up with tutors from ten regions, covering courses from Openings to postgraduate level and across a wide range of subjects. The tutors are developing materials to suit their students and courses, using alternative media that can be accessed by computer and through mobile devices (Keegan 2008a).

2. Mobile Learning at the Fernuniversität in Hagen, Germany

Germany was quite early in establishing a dedicated distance university with the establishment of the Fernuniversität in 1975. The Fernuniversität has approximately 46,000 students in a wide range of subjects leading to a number of different degrees. Online learning has from 2004, after some years of project trials, been an integral part of the learning system. Still, in the research of the Megatrends project, the Fernuniversität, was not considered a megaprovider of e-learning (defined by either over 5,000 students or over one hundred courses where e-learning represented more than 50 percent of the content/activities of learning). http://www.fernuni-hagen.de/english/ (See Arneberg et al. 2007.). However, as a research university the Fernuniversität has carried out some projects on mobile learning applications in some of its subjects.

Mobile Centre of Excellence

The Fernuniversität is an active partner in the Mobile Center of Excellence, that operates its own web-site, http://www.mobile-education.de/. It is a collaborative research project involving both academia and industry. The Center aims to develop both didactical/methodological and technological aspects of the mobile Internet, through observation and documentation of
current (and future) developments and research on mobile learning. Partners are:

- the Fernuniversität in Hagen ([http://www.fernuni-hagen.de/](http://www.fernuni-hagen.de/)),
- Hagener Institut für Managementstudien e.V. ([http://www.fernuni-hagen.de/hims/index.php](http://www.fernuni-hagen.de/hims/index.php)) (which is a department of the Fernuniversität),
- Peperoni ([http://www6.peperoni.de/](http://www6.peperoni.de/)) (a mobile and Internet software firm),
- Wisnet e.V. ([http://www.wisnet.de/](http://www.wisnet.de/)) (an interdisciplinary knowledge network for e-learning in the Rhein-Ruhr region) and
- Avinotec GmbH ([http://www.avinotec.de/](http://www.avinotec.de/)) (a firm working with network, telecommunication and Internet technologies).

As the only dedicated distance teaching university in Germany there is no wonder that the Fernuniversität has put emphasis on developing online learning solutions and in this connection also experimented with solutions for mobile learning.

The Fernuniversität was partner in the two EU funded Leonardo da Vinci projects, ‘From e-learning to m-learning’ (2000-2002) and ‘Mobile learning – the next generation of learning’ (2003-2005) led by Ericsson Competence Solutions in Ireland. During these projects the project teams of the Fernuniversität developed theory and practical trials on mobile learning related to distance education.

Statistics course on smartphone and other handheld devices

In the first mentioned project above, the partners experimented with development on different types of handheld devices, different versions of WAP phones and PDAs. The research group at ZIFF, Fernuniversität, took responsibility for developing and testing of mobile learning modules on the Ericsson R380 using WAP technology. The course trialled was an introductory course in statistics. The Fernuniversität … team soon realised the restrictions of this narrow task and made up its mind to provide the course on all platforms suitable for mobile learning. Only this way allows for a realistic opinion of the suitability of all different devices and media for mobile learning. Particularly, great efforts …were… spent on the implementation of all the communication channels necessary for successful mobile learning from didactic reasons” (ZIFF 2002).
Figure 1. Devices applied in the first mobile learning experiments carried out by the team at Zentrales Institut für Fernstudienforschung (ZIFF) at the Fernuniversität.


The developments and try outs of the mobile learning solutions developed by the Fernuniversität in this project are extensively accounted for by Ströhlein & Fritsch (2003). This document describes and discusses technical solutions, student experiences and cost considerations.

It seemed clear that the students appreciated the hands-on sessions practising mobile learning using smartphones, PDAs or comparable devices. But for the purpose of working through complex material the students would only use a PDA and not a smartphone.

It was also concluded that research is necessary to analyse under which circumstances HTML or comparable formats are to be used and when eBooks are to be preferred instead. Preparing the first generation of mobile devices for access to the internet was seen at that time still too complicated for the average user. The usability of mobile devices has to be improved significantly before they will be widely accepted for mobile learning Ströhlein & Fritsch 2003.

‘Histobrick’ and mobile learning on university level

In the second Leonardo da Vinci project mentioned above, the Fernuniversität, represented by the Department for mathematics and informatics, researched on possible solutions for development of a ‘mobile learning management system’ (mLMS) suitable for academic mobile learning at the university level. Learning philosophy and technical solutions are well documented by Ströhlein (2004a, 2004b).
Based on the experiences from the preceding project, the Fernuniversität team decided to develop a prototype of a client based game like mobile learning module for statistics learning called ‘Histobrick’, that aimed to provide a ubiquitous tool for examining and deepening one’s knowledge about statistical distributions and their most important characteristic numbers. This game like solution supported spontaneous study sessions on the move using mobile phones to test knowledge of statistical concepts.

The evaluation of student use indicated that the main idea of capturing the students’ attention in distracting environments by providing a game like learning experience worked well. However, feedback from the students showed that mobile phone learning is only regarded as a value adding element to PC based technologies if the design of the mobile learning solutions manages to eliminate obvious shortcomings of phones compared to PCs (Ströhlein 2005).

Krämer (2005) has described the second developments during the second Leonardo da Vinci project, where a specific learning content management system, FuXML was used to extend cross-media publishing features from paper and laptop to mobile devices, phones and PDAs.

Figure 2. FuXML content management and cross-media publishing system (Krämer 2005).

Didactic profiling: Supporting the mobile learner

Another project at the Fernuniversität researched solutions for providing the students with appropriate and reasonably usable learning materials at any time and at any location. The idea was to prototype design a development environment to become the heart of a pocket university. The main purpose of
the project was to make learning, teaching and collaborating via mobile devices accessible to students, no matter, where they are currently located.

The solutions assumed that the students would have their cell phone, smartphone or PDA at hand. It was shown that the well known technical profiling is one part of this assistance. One also needs to know about the learner’s attitude, preconditions and to take into account the strong impact of the learning situation on the learning process. A didactic profiling system in which students where provided with only those didactic resources which can reasonably be used under the given environment conditions was developed (Becking et al. 2004). The work on profiling has also been presented by Bomsdorf (2005).

*Mobile learning in advanced courses of economics*

Parallel to the above mentioned projects, the Department of Business Administration and Economics researched on mobile learning solutions representing subject elements of a graduate course. Also in this project the mobile learning activities were based on the assumption that the students already had worked with the materials through ordinary learning methods including the Internet. Short modules were prepared to test learning using multiple choice questions etc. In addition attention was directed towards increasing student-student interaction. Also learning materials on video were distributed (Kuszpa 2004, 2005b)(Rekkedal 2008).

3. **Mobile Distance Learning at NKI Distance Education in Norway**

As shown by the Megatrends project (Arnberg et al. 2007, Paulsen 2007) relative to the population, Norway is a leading country concerning distance and online education, with 4 megaproviders of online learning among the 26 European Megaproviders that were analysed. Two of these were distance teaching institution with a long tradition of offering distance education courses in Norway.

One of these, NKI Distance Education, which also was a pioneer in developing online learning, has experimented with mobile learning as an integrated service of the online learning system for many years. There is no information that other distance teaching institutions in Norway have offered mobile learning solutions (see Rekkedal 2008).

NKI has during the last 6-7 years developed mobile learning services as an integrated service of online distance education. The developments have been part of research and development activities related to a number of EU supported Leonardo da Vinci projects. The main projects were: *From e-learning to m-learning* (2000-2003), *Mobile learning- the next generation of learning* (2003-2005) and *Incorporating mobile learning into mainstream education* (2005-2007).

Most NKI courses are not designed to function as online interactive e-learning programmes, although some parts of the courses may imply such interaction
with multi-media materials, tests and assignments. The courses normally involve intensive study, mainly of text based materials, solving problems, writing essays, submitting assignments and communicating with fellow students by e-mail or in the web based conferences. This means that most of the time the NKI students will be offline when studying.

When developing system solutions for mobile learning, it is assumed that the NKI students normally will have access to a desktop or laptop computer with Internet connection. This means that the equipment and technologies used when mobile are additions to the students’ equipment used when studying at home or at work. It is also assumed that mobile learners study in the same group as students not having access to mobile technology. Thus, the learning environment of NKI is designed to cater efficiently for both situations and both types of students.

During the first project, NKI developed solutions for mobile learning applying mobile phones and PDAs with portable keyboard. Learning materials were developed mainly for downloading to the PDA and off line study, while online access to forum discussions, supplying forum messages, reading in forums and communication with fellow students and tutors and submitting assignments were handled online via mobile equipment when students were on the move.

During the second project NKI developed and tested solutions for an “always online multi-media environment” for distance learners based on the use of PDA with access to wireless networks. During the project NKI first developed one specific course for mobile access with PDA. However, cost efficiency considerations require server side solutions that make access independent on devices on the user side. Thus, during the second year of the second mobile learning project NKI installed software and solutions that in principle made all online courses accessible independent of devices on the receiving side, e.g. most types of pocket PCs and mobile phones.

One of the main challenges concerning the mobile devices was to find acceptable solutions adapted to the small screen. There is simply not enough space on a small screen for all the information found on a traditional web page. Another problem was the limited data transfer rate and processing power found in mobile devices. When people use a mobile device with Internet connectivity, the connection speed is traditionally lower for instance via a mobile phone. Thus, the project actually tried out solutions designed for a future, as the NKI research group believed it might be, with online high-speed access wherever the student is.

The aim of the third project was to develop mobile learning course content and services that will enter into the mainstream and take mobile learning from a project-based structure and into mainstream education and training.

Although it was difficult to foresee what would be the technical solutions for mobile devices in the years to come, there is no doubt that the research on mobile technology in online distance learning at NKI over the years has
inspired developments that also have increased the overall quality of NKI online distance learning.

Context

NKI Distance Education is the largest distance teaching institution in Norway, recruiting 7,000-10,000 students every year. NKI Distance Education was one of the first institutions worldwide to offer online distance education when we started the first trials on our in-house developed Learning Management System, EKKO (Norwegian acronym for “electronic combined education”), in 1987. Since then online education has continuously been offered to an increasing student population. In December 2007 NKI has approximately 9,000 active online students, studying one of more than 80 study programmes or over 400 courses offered on the Internet/Web.

In 2001 NKI launched the 4th generation online distance education system at NKI when introducing the internally developed LMS, SESAM (Scalable Educational System for Administration and Management), that totally integrates the web-based Learning Management System with the overall Student Administration System and a number of other applications for efficient operation and administration of the logistics and student support measures in online distance education (see figure 1). We consider the total integration of distance education IT systems as one major prerequisite for operating efficient and effective large-scale distance education. A description of SESAM and functionalities has been given by Paulsen et al. (2003).

![Figure 3. NKI’s integrated systems for online administration and student support.](image)

When engaging in the EU Leonardo da Vinci mobile learning projects, the NKI research and development group was very decisive that our aims would be to develop solutions that would increase access and flexibility and refine the total
distance learning environment to meet the needs of the ‘mobile distance learner’.

In December 2007 NKI launched the SESAM 6.0 Learning Management System, that was based on Open Source technologies and Web 2.0 functionality. Because still relative few students access NKI courses using mobile devices, services for mobile learners were not given first priority when developing the new solutions. Solutions for mobile learners will be added in the future.

Increasing the flexibility of distance education

A number of evaluation studies among distance and online learners at NKI have demonstrated that students emphasize flexibility (see e.g. Rekkedal 1990, 1998, 1999, Rekkedal & Paulsen 1997).

NKI has chosen a philosophy for the development of Internet based education at NKI: Flexible and individual distance teaching with the student group as social and academic support for learning. NKI recruits nearly 10,000 students to more than 400 courses and over 130 study programmes by correspondence based and Internet based distance teaching every year. In 2006-2007 around 70 percent of the students choose online study.

The students may enrol to any course or programme or combination of courses at any day of the year and progress at their own pace. This flexibility does not exclude group-based solutions in cooperation with one single employer, trade organisation or local organiser, nor that individual students on their own initiative or by the initiative of the tutor are collaborating on learning tasks. According to NKI philosophy on online learning as expressed in the strategic document (NKI 2005): “NKI Distance Education facilitates individual freedom within a learning community in which online students serve as mutual resources without being dependent on each other.”

Concerning the challenge of supporting distance students within a flexible distance learning context to identify and invite fellow students to become a ‘learning partner’ NKI has developed different kinds of social software solutions within the LMS-system e.g. all students are urged to present themselves in ways that invite social interaction for learning purposes. This information may be open to all members of the learning society of NKI Distance Education, to fellow students studying the same programme, or to tutors and administration only.

Student lists contain information about where students live and which module they are studying at any time. Software solutions for inviting and accepting learning partners and for establishing connections have been developed parallel to the research on mobile learning Paulsen (2006). There is no doubt that mobile technology may increase possibilities for efficient interaction between distance students, making them more independent of time and space. The potential of social software for developing solutions that allow students within ‘maximum freedom and flexibility’ modes of distance learning
to engage in cooperative learning activities has been presented by Anderson (2005).

From the discussion of NKI philosophy of learning and views on knowledge and aims and objectives in formal studies, the NKI research group came to the conclusion of experimenting on mobile learning based on a more advanced technology than what was available on mobile phones in 2001, the WAP and Smart phones. Thus, it was decided that the Compaq iPAQ PDA in combination with mobile phone communication was suitable for the purposes.

“From e-learning to m-learning”

The main objective of the first NKI mobile learning project was to extend the distribution of learning materials and communication to lighter equipment, specifically PDA and mobile phone. During the first project it was understood that for NKI the longer term challenge would be to develop the system and server side to present materials in ways suitable for PDA and other mobile technologies and to find acceptable solutions for access to and interaction with learning materials and for teacher-to-student/student-to-teacher and student-to-student communication. Parallel to the mobile learning projects NKI was engaged in projects on developing ‘universal accessibility of distance learning’ (Mortensen 2003) (which has similar consequences concerning server side solutions for making content available to anyone independent of physical handicaps or technology on the receiver side).

The aim of NKI in designing the environment for the mobile learner was to extend and enhance (or restore) the flexibility of distance education, that to some extent took a step backwards when converting from paper based to online learning, where students largely were required to study at a place (and at a time) where a computer with access to the Internet was available. This aim was also in focus during the second and third m-learning projects.

When planning for the mobile learning environment of the first project the NKI project team had long discussions on whether to develop learning materials for online or offline study. It was decided that the learning environment for the first course should include the following aspects (Fagerberg, Rekkedal & Russell 2002, Rekkedal 2002a):

Technology:

- Pocket PC/PDA
- Mobile phone
- Portable keyboard

Learning content and communication:

- Learning content to be downloaded on the mobile device to be studied offline. Downloaded content to include all course materials:
  - Content page
  - Preface
Intro”.

Students’ and tutor’s use of technology when mobile

When mobile – and using mobile technologies – NKI found that it was generally satisfactory for the student (and the tutor) to have the course content available to study on the PocketPC. In addition, the following communication possibilities were seen as necessary. When mobile, the student must be able to:

- Access the course forum archive to read messages (if necessary) (messages on the forum are also sent to participants as e-mails)
- Access the course forum to submit contributions to the discussions
- Send e-mail to fellow students, to the teacher and to the administration (study advisor)
- Receive e-mail from fellow students, from the tutor and from the administration
- Submit assignments by e-mail including attachments
- Receive assignments corrected and commented on by the tutor including attachments.

To access e-mail and discussion forums, mobile phones with infrared connection to the PDA were used.

Main conclusions from Project 1 trials

NKI found that downloading and synchronizing learning materials to the students’ PDAs caused few (or rather no) problems. The learning content was delivered in two versions, HTML and Microsoft Reader e-book format. As the preference for the e-book format was so clear from the first trial, in a second trial, the course applied e-book materials only. Illustrations were considered unacceptable on the PDA. Taking notes was found to be a problem, so for the second trial it was found to be necessary to equip the students with keyboards, that actually solved the problem, including writing longer texts in connection with assignments etc. Communication via mobile phones for submitting assignments and writing messages to the course forums were found to be easy, with few problems and with acceptable costs – on the condition that texts normally were produced offline.

The main aim in designing solutions for mobile learners at NKI was to maximize student freedom and to support online learners who also are mobile when studying. It was a clear message from all the participants in the pilot
trials that the main advantage of mobile learning as designed in the trials, was the increased flexibility of online distance education (Rekkedal 2002b, 2002c).

“Mobile learning: the next generation of learning”

As a result of the experiences from the first project, NKI continued research on mobile learning based on the PDA solutions available 2003-2005. After examining the different brands available, it was decided to develop solutions for the follower of the previous devices, HP iPAQ Pocket PC 5500 series with built-in wireless network card. At the same time all developments were done with the main object to develop generic solutions independent on devices on the user side.

For NKI as a large-scale provider of flexible online distance learning, it is extremely important to deliver cost-effective solutions, i.e. it is of vital importance that one is able to find system solutions that allow learners who are users of mobile technology and wish to study also when on the move, that also allow other students to apply standard technology. This means that one had to look for solutions that were optimal both for communication and for distributing content in courses, independent of whether the students and tutors apply mobile technology or standard PC and Internet connection for teaching or learning.

Functionalities of the “always-online environment” developed by NKI in the project “Mobile learning: the next generation of learning”

During the first year of the project a special version of one specific course was developed for mobile access and communication. It was concluded that if specific additional materials had to be developed for the mobile learners, the solutions could never be applied cost-effectively on a large scale.

Consequently when planning for the second year of the project it was decided that the solutions should be generic and available in all courses and that the result should be “an always-online solution” that would possibly increase the quality of the services for mobile learners (Dye & Fagerberg 2004):

- High bandwidth gives fast downloading of course content and use of audio, video and advanced graphics
- Independence of synchronization with desktop PC
- Access to resources on the Internet at all times
- Easy access to e-mail at all times
- Possibilities for online assessment and assignments and ‘in-course-activities”
- Options for easier co-operation with fellow students
- Possibilities for synchronous communication, chat and IP telephony
- ADSL or free access to WLAN give control over costs

During year 2 of the project NKI developed SESAM into a functioning mLMS. The system was tried out during March 2005 with 18 test students registered on the course “Sales and services” (Dye & Rekkedal 2005).
Incorporating mobile learning into the mainstream of education and training

The project ‘Incorporation of mobile learning into mainstream education and training’ was started in October 2005 and was be finished in September 2007. This project was based on the partners’ experiences during the two preceding projects and on the views that it is now time for mobile learning to transform from its project status and enter into mainstream education and training in Europe. Equally important aims of the project are to develop and test solutions for mobile technology in distance education and to disseminate information to interested parties in Europe and worldwide.

For NKI, the project built on the situation that all online distance courses were available on PDAs (and also on smart phones with web browser) without any need for adaptation of the individual courses. In this situation the project sought to develop services using primarily SMS technology to support online distance education within the context of cost-efficient large-scale distance education. The infrastructure for the additional new services was developed to be applied in all courses.

Possible services

According to Russel (2005)(planning paper for the project) there are numerous possibilities for the use of SMS/MMS services that could be suitable for supporting online distance learners. NKI practices flexible pacing and free start-up times and has developed advanced support systems to follow-up both students and teachers. In the NKI context it was assumed that the following services might be developed and implemented for mobile technologies during the project:

- Password retrieval for students who have forgotten their password.
- Welcome message with user name and password. Included would also be basic ‘how-to’ log on to the web pages. This message could also include contact information for easy storage on a phone, as well as links to other services that are designed by NKI to be used from a mobile device. The message may also include a question for permission to communicate to the student via mobile phone.
- The introductory course ‘Learning to Learn’ will be designed specifically for delivery to mobile devices, preparing the student for what to expect as a distance student at NKI. We hope to also to give the student an introduction to study techniques in a lightweight version made available for mobile via WAP.
- Reminders to students who fall behind their planned progressions schedules.
- Reminders to students for exam registration. We would also like this system to include the possibility for the students to enrol for exams via the mobile phone.
• Delivery of interactive quizzes.

• Notification to teachers when students have submitted an assignment; it would also be useful for notification to be sent only when the teacher is late in responding.

• Notification to students when grades on submitted assignments are registered.

• Introduce a web interface to allow teachers and administrators to send SMS messages to students and allow students to send messages to other students.

• Allow students to upload pictures and text to their presentation.

• Allow students to upload pictures and text to their blog.

• As much of the NKI teaching/learning site as feasible to be made available to mobile web browsers.

During the project, only a few of these services were developed. SMS services have been used both for marketing purposes and for sending information to distance students. The NKI LMS, SESAM, was adapted to send SMS messages to students.

In the previous, above mentioned, projects on mobile learning the focus was mainly on course content and communication. In the third mobile learning project NKI wanted to focus on extra services that could increase the online students’ experience of being closely followed up by adding new mobile services, such as SMS messaging integrated with the Internet based content and communication services. At the beginning of the project NKI implemented a SMS gateway capable of sending and receiving SMS messages to and from the server. This service was integrated in NKI’s administration system for online students and available to staff.

For testing purposes, NKI decided to send SMS messages manually to selected students asking them to correct their e-mail address after receiving an error from trying to send them an e-mail. This approach proved to be a success, and after a while some of the NKI online tutors started generating messages they wished to be sent to one or more of their students.

When NKI was satisfied with the logging of the service, it was put in production and used to send messages to students who had an error with their e-mail address. These were sent as bulk SMS messages to test the response. After sending several hundred SMS messages it was found that approximately 70 percent of the students, who had received an SMS message, changed their e-mail address and which enabled NKI again to send information to these students.
SMS services

NKI then proceeded to developing SMS services that could benefit most of the approximately 9000 online students. One of these services was the course Learning to learn that was developed as a light-weight WAP course. This course was linked to in an SMS after enrolment. The translation of that message was:


The link takes the student to the course that gives a quick introduction to how it is to be a student at NKI. Other services that NKI developed through the project were (in English translation):

E-mail error message:
NKI can not reach you at the email address xx@yyy.zz, please log in and correct the address

Exam reminder:
Your exam in “Learning to learn” is on the 27th. September, hope you are on schedule. Kind regards from NKI

Forgotten password:
Your password is xxxxxx

New comments on assignments:
Comments for “Learning to learn” is available, please log in to see the comments

Exam results are available:
Congratulations on finishing the exam, your grade is available online

The technical challenges were seen to be small and the cost of sending SMS messages are far lower that sending letters by post or making phone calls to the students.

The final evaluation showed that NKI online students appreciate mobile services in general and are very positive towards the use of SMS services.

NKI conclusions from mobile learning development and research

“The NKI developments and research on mobile learning in connection with the three EU Leonardo projects have resulted in better solutions for serving distance online learners. We have learned that cost efficiency considerations do not allow for developing parallel versions of courses. Courses must be developed, presented and distributed in ways that allow both mobile and not mobile distance learners to participate in the same course, and that course materials can be accessed both by standard and mobile technology with acceptable quality of all content elements. Interaction with course content and
multi-media materials, as well as communication with tutors and fellow students, must also function adequately both through standard and mobile technology.

It is still a question of what the ‘ideal’ device and solution for mobile learning really will be. Probably is the answer a result of the learner’s individual preferences. That is why NKI has found it extremely important to experiment with different solutions that have inspired developments towards finding course design and system solutions that may serve the needs of the learner independent of the technology used.” (Rekkedal & Dye 2007, p. 19.)

(Information on mobile learning at NKI Distance education from Rekkedal & Dye, 2008, Rekkedal 2008).

4. Mobile learning at Dirksen Opleidingen in the Netherlands

Dirksen Opleidingen (http://www.dirksen.nl/) is a private educational company in the Netherlands offering both distance education programmes, fulltime and part time courses mainly in electronics and information and communication technologies. According to the director, who has been active in European distance education for instance as chair of the Research and Development Committee of the EADL (European Associaton for Distance Learning), the project on mobile learning was inspired by project dissemination, articles and papers from NKI Distance Education in Norway.

Dirksen Opleidingen argues for mobile learning that mobile learning gives more flexibility to the distance learner for instance by making solutions for studying while commuting on train, in the car (or even when out jogging (?)). In addition it is argued that mobile learning increases the quality of services by supplying information quicker and totally independent of where the students are. The services have been offered to be received and applied on mobile phones, iPods or PDAs.

According to Dirksen Opleidingen the condition for being able to supply mobile services in distance education is that the supplied materials are easy to use, that the extra added value is worthwhile relative to costs and that the costs are relatively marginal to the total course costs.

Mobile services

The first mobile service tried out by Dirksen Opleidingen was information on exam results. Before the exam all candidates were asked to supply their mobile phone number. Those who did received information on their exam results within three hours after the exam was finished. Evaluations showed that the students were very satisfied with the service. In addition the institution managed to get rid of all telephone calls about exam results and thus saved a lot of personnel time. Close to 90 percent of the students took advantage of the service.

Another service offered by Dirksen Opleidingen was SMS questions for repetition before exams. The service was offered to a group of 60 students in
a 3-5 months course for technicians working in one company. 68 percent said that they had used the service. Most of the users said that the solution was easy to use and 68 percent said that the service had positive effect on their exam results.

The last service offered is a special web page for mobile access that allows students to access relevant and updated information from their handheld devices.

All in all Dirksen Opleidingen considers mobile applications to increase service, quality and flexibility of distance education (van der Mark 2008).

CONCLUSIONS

The above examples should be seen as examples only that distance teaching institutions are engaged in research and development on mobile learning issues to develop the distance learning environment adapted to the new technological scene. As quite rightly pointed out by Keegan (2008b) there is an accepted truth that it is not necessarily the technologies with the best inherent pedagogical qualities that have triumphed in distance education, but rather technologies that have been generally available to people. And it has never been a technology that has been available to citizens in all parts of the society both in developed and developing countries as mobile telephony. It does not require much fantasy to see that mobile technology will be important for developing quality, access, flexibility and learning support to distance learners in Europe and the rest of the world.

Distance educators cannot overlook mobile learning and mobile technologies when preparing and developing learning environments in the years to come.

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1 – m-learning in the context of European continuing education

The use of ICT in continuing education and lifelong learning is evolving very rapidly following technological and pedagogical evolutions.

These advances have facilitated the use of mobile devices, through the use of wireless networks or telephonic operators' networks for Internet access. This fact has clear implications in education and training, as it offers a great potential when making possible the access to learning contents anytime and any place.

The modes of learning available for professionals at organizational and corporate levels have changed the way adults learn, from e-learning to m-learning.

Today professionals have different learning possibilities both formal and informal and can customise the learning modes to their learning needs. These range from browsing the web to accessing content repositories, working in social networks or participating in different communities, independently, anywhere, anytime.

The integration of existing e-learning systems with m-learning devices can bring to light new forms of learning for more flexible and mobilized workers.

The most part of a corporation's professionals use company PDAs or smart phones that allow them to browse and send/receive emails and to retrieve information from their corporation's information and knowledge systems and portals. The use of these devices is, in general, limited to administrative information exchange or project management and less used for formal learning purposes, and that is a major challenge for m-learning.

In the last 10 years m-learning research has been carried out, mainly in the context of universities. The research proves that m-learning can be very convenient for communicating with a new generation of students, who can download and retrieve information and knowledge to their mobile devices. The type of uses of the mobile phone range from university administrative information (SMS notification for administrative deadlines or classes) to specific learning content or to access the university LMS or other learning technologies like the Library Content Repositories.

The greater part of the research occurred in a context where:

- Students are keen users of mobile devices,
- The most recent devices are available to use within the research
- The content and experiences are measure by experts.
Research on m-learning in the context of life long learning and/or continuing education was also carried on in the last 10 years, the research carried out in the context of the medical sector being of special relevance. In this case the experiences carried out were also, in the majority, in a “lab context”, meaning that the most part of the experiences that users had were with the same type of mobile phones or PDAs, that were used for testing m-learning content.

Experiences using the course participant’s own mobiles phones, change dramatically this view. In fact the type of mobile device, as well as the operating system or capabilities of the phone, can limit the m-learning experience.

In this context it must be underlined that life long learning is directed to adults and adults are not (usually) the keenest users of mobile phones. Additionally the adult’s knowledge about mobile devices is very dependent on local/regional factors, such as the type of device, the infrastructure available and the price of communications.

In a pilot experience carried out in Portugal in 2008, for instance, it was clear that public servants from different areas of the country did not have the most recent mobile phones and the ones that had PDAs or smart phones were not using all the functionalities and could not operate m-learning content without the help of the trainer.

The research showed that trainees are using the mobile phone essentially for:

- Spoken conversation
- Sending/receiving text messages
- Taking photographs
- Filming Videos
- Assessing e-mail (only a few)

Today the most part of mobile phones provides access to a number of features that can be used not only for information and communication but also for learning.

That means that one part of the professionals in the world can have access to a technology that can provide them with the information and knowledge they need independently just in time.

As a complex portable device the mobile phones can be used for static and dynamic learning, having different modes of operation that allow users to access, send and communicate content, voice and images:

- As a static storage device the user can store/produce images, videos, music, quizzes, glossaries, games and in a self learning mode operate the device to learn.(as a content management system).
- As a dynamic device the learner can produce, send and download all types of media files and operate with mobile phones for learning purposes. Most part of the learners use the devices mainly for spoken
conversation and to produce and share images, send/receive SMS and to play games.

Thus m-learning should focus on these types of uses to produce an m-learning design that is suitable for the actual users. This means that new ways of feeding the learning processes and innovative pedagogies should be put in place in order to have an effective learning process.

The techniques for using innovative learning procedures with mobile devices are crucial for the development of continuous training.

2 - m-learning challenges for life long learning

m-learning developments bring new challenges to continuous training and life long learning, obliging the community to reflect on new learning designs. This implies changes in the learning methods, the design of contents, the training strategy, as well as changes in the learning management systems, content management systems and other supporting systems.

On the one hand the IT companies specialized in content and platform development, are starting to launch new products and services allowing the capitalization of this tendency; and on the other hand the market search for this kind of learning products for mobile devices is still limited but there is a huge potential and the market is taking its first steps.

Companies like Hot Lava and open source projects like the MLE project are leading the way to provide innovative answers within the m-learning field.

Hot Lava Software tools are used at universities and corporations around the world to create J2ME based and Windows Mobile and iPhone mobile learning, testing and surveys.

The Open Source project MLE is a learning software for mobile phones which has been designed for mLearning. The MLE is the client on the mobile phone and is realised in J2ME. As a back-end an LMS (Learning Management System) is required. The MLE and M-Learning is currently being tested by a school in Graz (Austria).

The e-learning related companies are also moving in the m-learning direction. Companies like the ones that produced Camtasia or ToolBook are developing efforts to create m-learning authoring tools and frameworks for integration with existing e-learning technologies.

LMS companies like Blackboard or Docent are developing wireless mobile access to specific aspects of learning courses, like a calendar, the time schedule and other administrative aspects.
Thus m-learning is becoming the new and real way of distance education, integrating e-learning capabilities and creating new forms of learning anytime, anywhere.

The two areas (mobile content production and connection of mobile devices facilities to existing e-learning systems) represent the bigger part of the m-learning market.

The development of small courses and access to the “courses agenda”, plus SMS administrative notification, represents a logical migration to the mobile technologies. This migration reveals an area of imagination on the potential unlimited new ways of learning this technology can offer.

- m-learning brings to the learning field new challenges not only as a solution but also as a complement to existing e-learning formats and models of learning, as it can integrate all the features of the collaborative and informal dimensions of learning. When integrated with web 2.0 tools and applications it may enhance a constructivist learning environment with emphasis on collaborative learning (Social networking, Wikipedia, bookmarking, Tagging.)

3 - Learning with mobile devices

The use of m-learning solutions for continuing education is highly dependent on target groups skills and access to technology.

M-learning is a recent way of mobilizing learning contents which are of great value to the valorisation of knowledge communities. New ways of learning demand a new pedagogical design integrating different learning scenarios, from face to face learning, to the use of e-learning platforms and m-learning devices. All these learning experiences should be integrated and able to accommodate users and providers.

In the Portuguese research study face-to-face learning, e-learning and m-learning were integrated: The learners were public servants working in Municipalities and ranged between 28 and 60 years old.

1. Face to Face course: mobile technologies for tourism sector
   - E-learning platform used as a complement to face to face learning classes
   - M-learning content available throughout the e-learning platform
   - Face to face course, using an e-learning platform and integrating m-learning content used in face to face classroom
   - 15 learners – from Municipalities in the North of Portugal

2. e-learning Course: Web 2.0 technologies
   - E-learning platform used for course delivery
   - M-learning content available throughout the e-learning platform
   - e-learning course (with a e-trainer support)
• 20 learners from the 18th Municipalitiy in the Lisbon Metropolitan Area.

The learning design experience was based on a combination of learning modes: face to face, e-learning and m-learning and also made of a combination of learning technologies (e-learning platform, e-repository, content authoring system, and mobile technologies).

Results

• The majority of learners have simple mobile devices (2G) rather then smart phones or PDAs
• The majority of learners do not have a connection to internet on their mobile devices
• Costs of mobile internet access is still prohibitive in Portugal
• Variety of students’ equipment
  o Different technologies
  o Different Operating Systems
  o Different Screen Sizes
• learners didn’t have Wireless equipment
• Lack of competencies using m-devices
  o The learners that have smart phones and PDAs do not have the skills to use their mobile phones properly (for the purpose of downloading content from a website to their mobile phone).
• Face to face instructions and instructor led learning was needed to teach the learners to use their mobile learning content on their devices
• Learners have basic mobile phone using basic skills (they are able to use SMS and transfer images but not much more.)
• If the mobile content is not simple to use it is not used.

This experience was very important to understand that on the one hand technology available by learners’ is not yet the mature technology for m-learning. On the other hand this type of experience demanded customised solutions (and programming) to be able to develop the content for up-load to different mobile devices with different operating systems. Plus the learners did not have the necessary skills to operate their mobile phones together with the e-learning platform, so they could not download materials in a self learning way.

4 – m-learning: new learning scenarios for professionals

The 3rd generation mobile phones (3G) are able to run JAVA programs, to run Internet browsers with the capacity of using XML data and the capacity to download programs. That means that this generation of mobile phones is more mature for running m-learning applications and solutions.
Example of a 3G Mobile Phone

With this device it is possible, for instance, to create a scenario where the learner listens to small recorded explanations by the teacher about a specific topic. Another possible learning scenario is to use a conference if the learner is outside the office and in that way he can collaborate in group discussions or interact in a discussion forum. The learner can also send/receive messages with images or videos with local contextual information about the discussion (or other material).

Finally, another type of learning scenario can be a test or a game, creating a competitive environment where learners or groups of learners are motivated to obtain better information and knowledge in order to score better and that will allow them a better understanding of the learning issues.

The portable devices are then in a state of deployment that allows m-learning experiences to occur without a great level of technology learning and software and hardware dependent development. Smart phones, PDAs, iPods and more recently iPhones are more and more likely to be found in the hands of learners. In fact, each day there are more and more people with internet access in their mobile devices integrating the mobile phone use with the laptop.

In addition to text, this information is in the form of images, animations, games, movies, videos, music, even maps and location services.

Additionally the use of mobile communities for m-learning is also a new trend to explore.

In Portugal, for instance, all mobile operators have recently created small communities based on the rate of their mobile phone. The advantage of these communities is that members can have free calls, free MMS, free SMS, and free videoconference if they call to a member of the community. More than that, some of these communities have also a website where people can share photos, messages, make friends, and be part of a community. We can identify
at the moment the following communities: Tag (optimus), Moche (TMN) and Yorn (Vodafone).

Those communities can be used as a way to trigger learning in a cost-effective way, as the costs of communication have been identified as a major barrier to m-learning development.

The first step for changing the current state of the art concerning m-learning is to begin with enterprise acceptance, including executives and IT professionals (the ones that probably use the most up-to-date equipment) that are able to re-think the hardware and software infrastructure. In certain cases mobility has already become an issue in a number IT departments.

Changing the infrastructure to include mobile phones (as an access point) is a first step.

A second step is to learn to use all the capabilities of the mobile phones and this learning is more useful for adults as well as for trainers, authors and learners.

At the moment and according to recent research for continuous education the types of dynamic learning tasks to develop and perform on a mobile phone are highly dependent on the mobile devices of the learners.

The typical learning tasks to be performed in a professional and life long learning context can be for instance:

- Testing, surveys, job aids and just in time learning
- Location-based and contextual learning
- Social-networked mobile learning
- Mobile educational gaming

Some more detailed examples of dynamic m-learning tasks are:

**SMS quiz:** Learners can text their answers to a specified number of questions

**Text language:** a series of activities designed to explore the language used in text messages, including speaking and listening activities, interpreting abbreviations, discussion topics and using normal phones or PDAs to practice sending messages.

**Quizzes:** short quizzes designed for different types of phones. The quizzes have simple content and are in the form of multiple choice questions.

**Learning Activities:** a series of paper-based activities designed to be used in conjunction with the quizzes, although parts of the activities are suitable for standalone use with learners. Activities include, word searches, spelling games and discussion topics.
Create a story: this is a group activity for learners using functions on the mobile phone to create a story. Stories can be written down, made with video or images (photos) or recorded and sent by text or MMS to another learner.

Riddles and jokes: a series of activities around riddles and jokes. Learners can solve riddles, record reactions to jokes and create short videos.

The design of the training courses and the content design should then be modified in a way that can give answers to the needs of the learners, according to their mobile devices. In any case (as in the case of e-learning) the development of contents for m-learning should take into consideration the type of issues to be learned or discussed, the types of tasks and activities to be delivered as well as the type of interactions to be performed in a specific learning scenario.

Considering m-learning as a just-in-time content delivery mode small units of learning should be created in order to create contents in a contextual framework emphasising the specific need of the learners, having more minimalist approaches and consolidating knowledge in more concentrated learning units. In fact the process of learning design should face different learning approaches from tutor led learning to self learning.

The most appropriate way of learning for professionals using m-learning contexts should then be the one that more easily is integrated into the learner’s day to day professional life, having available knowledge that can be downloaded to their phones as they need it and activities that can be performed whenever the learner wants. The integration of a learning programme with the learners’ working life should bring them the knowledge they need anyplace, anytime. Some authors argue (Norris & Soloway) that mobile devices should support project-based learning in context, that is, using the mobile phone as an integral part of a learning activity; most of all for ongoing assessment and possible feedback.

5 – Conclusions/Recommendations

The ways we learn will change dramatically in the next few years. Certainly there will be many movements in society in what concerns new forms of learning associated with technologies that are used globally.

The market of products and services in m-learning is currently emerging and will be responsible for millions of euros in the next years, changing the way people learn in universities, Research Centres, corporations and in all sectors of society.

More then a technological question, organizations (enterprises, training institutions, universities, etc) should reflect and discuss the way content is developed and how the learning experience is delivered, paying attention to the context of delivery and to the learning design according to learners’
needs. Thus didactical aspects are key success factors for this type of learning (as happened before with e-learning and distance education).

**Learning Design** for lifelong learning and for continuous education should then consider the learning environment, the learners and the technologies to be used. Organizations should also adapt their learning framework, integrating m-learning into their learning framework and into their learning offer. Nevertheless organizations should have in mind that m-learning serves, mainly, to support learners' performance, as it is made up of short intensive moments of learning. This fact is very important to distinguish m-learning from content production and learning design for traditional e-learning.

The European Union should invest more on the research and development of learning solutions for a more mobile working force in Europe providing them with mobile learning solutions.
PART 5

USING A PERFORMANCE-CENTRED APPROACH IN MOBILE LEARNING

INTRODUCTION

This is a model for other colleges and universities to follow showing how an existing Learning Management System (LMS) can be adapted to accommodate mobile learning.

Students, trainees and trainers, we are all becoming more mobile - over half of all students now spend up to half of their time in mobility. And there is quite a bit of evidence to show that people would like to make more use of this time for learning purposes.

Mobile devices are always available and can be used for a variety of learning functionality - providing access to content (both informational and instructional) and for communication and collaboration purposes. They can be used for formal or informal learning purposes as well as for performance support, i.e. for delivering information and support just-in-time and in context. Never in the history of the use of technology in education and training has there been a technology as available to citizens as mobile technology. It is clear that in the EU countries penetration is between 90% and 100%. Recent data from Telecom Austria shows that penetration of mobile services in Bulgaria currently exceeds 130 %. Thus it can be safely assumed that every student in every course in every further and higher education institution possesses one. What is more, they use them constantly in every walk of life – except their education and training.

Mobile devices are popular and well used by many people within our target groups. They are regarded as personal technologies, and as such likely to encourage a positive response. With the current rate of development, mobile devices will have the capability of delivering high quality, multi-media content at affordable prices within the next years.

An innovative performance-centred approach has been developed, tested and implemented in a number of European universities, high schools, vocational training institution, SMEs, within four pilot projects:

- Internet-based performance support system with educational elements (IPSS_EE) [www.ipss-ee.net](http://www.ipss-ee.net),
- Distributed Internet-based Performance Support Environment for Individualized Learning (DIPSEIL), 225692-CP-1-2005-1-BG-MINERVA-M [www.dipseil.net](http://www.dipseil.net),
- EPI- Educational Partnerships through ICT [www.5pieces.com/epi/](http://www.5pieces.com/epi/)
- SCALA Supervision and Assessment of Community-based Workpractice of Adult Workers for Accreditation and Learning
Our experience returned strong positive results - performance centred approach has been proven to be more effective than the traditional lecture-practice-test (expository inductive) in training higher order skills, for preparing learners for self-learning, improving, adapting for changing jobs. We need to build on previous work in the field – using a performance-centred approach in different educational and training contexts, and mobile learning experience, enhance the field of performance-centred education and training by the deployment of state of the art mobile technologies.

IMPLEMENTATION OF THE PERFORMANCE SUPPORT SYSTEMS (PSS) METHODOLOGY IN AN EDUCATIONAL CONTEXT

Our own experience in designing, developing, evaluating and implementing PSS in higher engineering and vocational education led to the development of Internet-based Performance Support System with Educational Elements (IPSS_EE), which has all the characteristics of a Learning Content Management System.

IPSS_EE, as a typical performance support system, is an integrated electronic environment, which is available via Internet and is structured to provide individualized online access to the full range of information, guidance, advice, data, images, tools and software to permit the user to perform a task with a minimum of support and intervention by others.

IPSS_EE differs from common PSS in two characteristics:

- IPSS_EE Tasks for performance aim preliminary specified learning outcomes;
- they differ in target groups - the IPSS learners (IPSS are training systems oriented to professionals) already know something about how the field works and how some of the tools might be used. Further, they are busy being practitioners in their field. These two factors – a working knowledge of the field and busy-ness – lead them to show little interest in envisaged learning outcomes. They want just-in-time, just-in-place learning that allows them to immediately apply their knowledge and skills to their professional lives.

In the "traditional" educational systems usually the expository deductive instructional strategy is used: content presentation, examples, sometimes exercises and, rarely task for performance. In these systems the conception of Learning Objects (LO)\(^*\) is common and traditional. One of the most popular definitions of Learning Object is provided by Dr. David Wiley, as “any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning are learning objects.” (LTSC of IMS: Wiley, Connecting LO’s p4). The LO model “presentation, practice, feedback” is a tool in helping to deliver information to students. That is, the learning object presents the information, provides the student with an infinite amount of practice (exercises), and provides a test that allows the computer to provide

\(^*\) Learning Object
feedback. Learning objects built on this information delivery model failed to provide solutions for IPSS_EE environment:

- students learn small amounts of discrete information at one time and slowly build a network of these information chunks. For instance, the Task teaches a single process or idea. Once that content is mastered, the student moves on to the next process or idea. Each task (object) is discrete and separate from the next. In the end, however, the student ties these discrete pieces together in order to understand larger ideas;

- IPSS_EE is a performance-based action learning environment. This environment involves the use and application of skills for finding solutions, making decisions, and thinking effectively, i.e. problem-solving skills;

- IPSS_EE environment calls for students to develop skills rather than build content bases - students have critical thinking and problem solving skills, communication skills, and know how to be a professional in their field rather than simply know about the field itself. In this light, IPSS_EE is an inquiry-based, constructivist learning environment. IPSS_EE lets students construct understandings of the field through doing and in this process they learn content knowledge in the service of accomplishing their task;

- IPSS_EE consists learning experiences and resources. It is learner-centered and open learning environment - complex problems link concepts and content to real situations, where the “need to know” is naturally generated.

IPSS_EE task for performance provides a combination of the following elements: reference information about a task or closely related set of tasks; task-specific training; expert advice about a task; automated tools for task performance.

Reference information describes the task that the user has to perform. This reference information supports the user by making immediately available information, which (s)he previously had to memorize or look for in a book or a manual. The reference section allows the user to learn more deeply about a given task and is always available for her/him to read and provides the theory behind the task it supports.

Task-specific training reduces preliminary training by helping the user to learn while performing the task. This type of training is learner-centred because the learner asks for help when he needs it to perform a task, and the help gives him the specific information that (s)he requests.

Educational performance support systems contain specific advice on performing tasks and it is its greatest advantage. The advice is usually provided by an expert system.
Automated tools for task performance are most helpful when a supported task involves the use of specific software.

The self-test provides an opportunity for the students to measure their own understanding of the content of the learning object. The students may revisit the test/reflective activity as many times as they want. The test doesn’t involve any interaction with the facilitators. The tests use computer-scored multiple choice items.

The learning process as performance-centred

The view of learning process, as performance-centred is highly effective as a means of providing students in professional education timely and relevant information. As a new technology, performance-centred educational systems will move the traditional teaching systems to training closely related to the job. These systems have a strong potential to help students mastering job-related skills. The message to the teachers, to consider the impact of teaching on results, good performance and competitiveness, is another perspective of this innovation.

The performance-centred approach in professional education integrates a wide range of technologies in its three components – content, information component and user interface. This integration gives advantages over the technology, traditional Web-based educational programmes and multimedia presentations. The integration of learning objects with job aids gives the students the possibility to gain an understanding of the content of the job aids. And in this way – minimises the main limitation of the job aids – the stage of understanding of the content. The information component provides the necessary knowledge for performing the task at the moment of need. The content is very focused, using the smallest unit. The timing, location and scope of the training integrates the learning experience with the task performance. This minimises the lag between the content presentation (or learning the content) and execution of the learned information. The student learns the content when it is needed for performing the task and there is no learning degradation.

The developed Web-based PSS provides user a friendly interface to move among the three main components. Web-based environment is common and desirable for the students.

Like most technologies, performance-centred approach has limitations. According to Ruth Clark (1992) there are three main limitations of using this approach for educational purposes:

- learning takes place in small increments and the learner loses the framework of the learning process;
- learners should be in control of their learning. Learner control seems to work best when the learner has some experience in the subject area;
computer tools automatically improve performance.

To reduce the first limitation the learners need a framework on which to build their knowledge. In the developed IPSS_EE courses we suggest the full picture of the course content on the first screen of the system. The user may perform separate tasks or go through the topics in the framework and finish with the final task for performance. The time for learning and the development of the courses picture are results of the user request.

The second limitation is connected to the subject of the course. We decided to give the user a possibility to make a pre-test aiming at a bigger motivation, self-evaluation of the knowledge in the subject area and as a result – the best working learner control.

The performance-centred methodology provides an opportunity for new form of learning, form which provides support for learning by doing and for working in the performance environment. The system has elements of performance system, elements of traditional Web-based educational program and automatic test system. The system uses a new technology for improving students’ competency and performance by providing support for processing, analysis and reflection on information and learning experience.

Application of a Performance-centered Approach in Mobile Learning – Reasons, Advantages, Disadvantages

The main reason is to contribute to the continued development of mobile learning and to address the imbalance between the availability of mobile devices and the lack of education and training provision on the sophisticated communications devices which every student and actively working person carries and uses constantly – except in education.

The application presents mlearning as a form of performance support system for educational and training purposes. The advantages for trainees are derived from providing learners with a job aid in the context of their work:

- puts training and performance support where the actual work takes place
- allows new skills or knowledge to be immediately applied
- enables training when it is needed
- allows use of rich media when appropriate

The advantages for students:
• students have more flexibility and choice in where and when they learn outside of the wired (or un-wired) classroom.

• students use the technology in their study that would enhance their readiness for tomorrow’s workplace where employers want graduates who know how to use technology for learning and working.

Given the trend to lifelong learning, many “students” are working adults with full- or part-time jobs. Mobility offers them an opportunity to maximize learning time.

The advantages to apply performance support in mLearning to create knowledge are derived from providing learners with a job aid in the context of their learning. Of course, these job aids can be greatly enhanced depending on the device. The device can be wired so as to get the latest information, and it can use visuals, text, and audio to deliver performance support. The advantages of this approach are based on constructivist theories of learning. The advantages of m-learning as communication stem from learners and experts constructing knowledge in an authentic context.

Wireless mLearning performance support systems are similar to traditional PSS. mLearning solutions integrate mobile devices with the learning to help the student to perform a task by providing information, guidance, and learning experiences when and where they are needed. Advantages include the following:

• *Enables training when it is needed.* Wireless and mobile learning can empower “teachable moments,” that is, times when those with a stake in a particular issue are attentive, willing, and receptive to learning. Using mobile devices, learners can access job aids, reference materials, or instruction when needed.

• *Allows use of rich media when appropriate.* Some of the wireless and mobile devices support rich media such as video, photographs, images, audio, and animation. If these media make instruction, reference material, or job aids more effective, they should be employed.

• *Provides access to experts.* Consider using wireless devices when there is a need to connect to and learn from experts. Using a PDA with instant messaging and awareness (the ability to tell if someone is accessible via e-mail, instant messaging, or phone), learners can access expertise.

• *Builds a community of practice.* Using wireless devices, a community of practice can contribute to a forum or threaded discussion. Questions and answers posted to the discussion forum can be accessed from the
Knows where your expertise is located by connecting and continuously sync training to back-end systems. Wireless devices have the ability to push and pull data to and from learners. The ability to connect and sync means that you can have training records that are current and easy to report on. A back-end system would track when learners need to take certification training and send the learner a reminder on the wireless device four to six weeks in advance of the certification expiration date. The leaner could then access the training and certification test online. The wireless device would send the certification test scores to a computer at headquarters and update the certification database.

The disadvantages of mLearning are a combination of technical and education challenges. Some of these disadvantages disappear if we apply performance-centred approach to mobile technology enhanced learning. It means that performance-centred method is very appropriate for mLearning pedagogical solutions.

There is some theoretical interest in building mLearning into existing education theory. This relates mLearning to an activity-centred perspective, essentially considering new practices against existing education theories. In a constructivist approach, learners are encouraged to be active constructors of knowledge, mobile devices embedding them in a realistic context, at the same time as offering access to supporting tools. Compelling examples of the implementation of constructivist principles with mobile technologies come from a brand of learning experience termed ‘participatory simulations’, where the learners themselves act out key parts in an immersive recreation of a dynamic system.

In the Constructivist world, it is vital that students create or construct their own knowledge. Sitting in a classroom and passively receiving knowledge from an authority figure is not in keeping with the principles of Constructivism. Interactivity is emphasised, however, it is important to acknowledge that this requirement for interactivity is not merely satisfied by the adoption of a mobile technology into the classroom environment. It is incumbent upon the designers of a mobile learning course to ensure that students are truly able to interact with the digital media in their learning environment. These media as accessed through the mobile technologies, whether video, digital or audio are important aspects in the creation of a learner- centred environment. The overriding importance, however, lies not with the technology, nor the digital media, but with the knowledge constructed by the students as they interact with these tools.
The pedagogical framework informed by the Constructivist and Connectivist school places the student at the centre of the learning process. Because emergent technology is exiting and newly available, it is easy to become absorbed by the technology itself. This is true both for researchers in the area and for students employing mobile technology as learning tools. However, it is important that the technology itself does not become a distraction or a diversion. Again, poorly designed or ill structured mobile courseware or a Virtual learning Environment may lead to frustrations and anxieties as students attempt to familiarise themselves with the system. Educators, developers and designers who strive for mobile learning environments with a sound pedagogical basis will take pains to avoid this occurrence. “An environment of tool should not be a hindrance, but rather an instrument for thinking and problem-solving (Fjortoft and Sageie, 2000).

A sound pedagogical framework based on developing the student’s ability to think creatively and form multiple perspectives on subject matter requires courseware incorporating tasks and subject matter that are authentic and based in the real world. It is not sufficient to develop a series of exercises that demand completion simply for the aim of applying a principle of knowledge. It is incumbent upon educators and developers to draw the tasks from those that the student would be likely to encounter in a real world environment.

A personalised approach to learning is central to a pedagogy based upon the principles of Constructivism and Connectivism. The mobile device is a pedagogic tool that enables students to acquire knowledge at a personal level. In order to offer a truly personalised experience, it is necessary to first understand the learners existing skills and interests. The Futurelab report Towards New Learning Networks advocates the following “Currently most discussions about increasing learner ‘choice’ and ‘voice’ are focused around giving learners a greater variety of routes through predetermined and predefined subjects and curriculum content. However, a truly personalised system requires that learners will not only have greater choice and influence over the pace, style and content of learning but that they are also supported to become active partners in developing their own educational pathways and experiences”.

This vision of students developing their own educational pathways requires that universities and colleges fully commit to the political agenda of personalisation. A starting point may be established in the creation of mobile learning courseware that exploits the affordance of mobile technology to personalise the learning experience.

Some disadvantages that may disappear, or be reduced, if the mLearning content is designed with the performance-centered approach in mind are:

- A Fragmented Learning Experience. The mobile devices could provide opportunities for review, listening, and speaking practice in a safe, authentic, personalized, and on-demand environment. The prototypes
developed let users practice new knowledge and experience new skills. Usually the learning requires concentration and reflection. However, being on-the-go (riding a train, sitting in a cafe, walking down the street) is fraught with distractions. Students are in situations that place unpredictable but important demands on their attention. This leaves the mobile learner with a highly distracted, highly fragmented experience. But, when we design the learning system as a performance support system the content is much focused, using the smallest unit with a framework for students on which to build their knowledge.

• Lack of Well-Developed Metacognitive Skills. Metacognition refers to the ability of learners to be aware of and monitor their learning processes. Adult education literature counsels that the more learners understand about how they learn best, the better able they are to assess how well they are learning and to manage their own learning. The challenge in wireless and m-learning is that learners have little experience with this delivery mode and the related instructional strategies. Experts (Peters, 2000) have suggested that “some employees are unsure about evaluating their personal learning experiences. The lack of external feedback can cause learners to question their goals and achievements.” Using m-learning delivery devices and strategies for self-directed learning doesn’t change this challenge. When talking about metacognitive skills, a distinction needs to be made between the learners’ ability to self-monitor and their ability to self-assess. Learners can easily monitor their progress against a plan that tracks task completion, time on task, and test scores. The more difficult metacognitive skill is self-assessment, the learner’s ability to judge how well he or she has actually done learning and transferring new skill and knowledge. Here, as in eLearning performance support system (IPSS_EE), the task performance is sent to the server in an electronic format, and for this the learner can use his/her own mobile device or personal computer and Internet access.

Some technological limitations of performance-centred mLearning may disappear as technology improves (these are limitations not only for performance-centred mLearning, but for mLearning in general). We point:

• Small Screens and Difficulty Accessing Information from the Web. Mobile and wireless devices have significant disadvantages relative to screen size and ability to access information designed for traditional PC-based Web viewing. If the mobile devices are accessing information from websites, Jacob Neilsen (2003b) advises: “Currently, the best we can hope for are websites that are basically scaled-down and redesigned to eliminate graphics and multi-column layouts. At worst, websites offer no mobile version, so you get crunched images and skinny columns that are almost impossible to read. Clearly, traditional websites are intended for a big-screen user experience. Putting them on a small screen is like the dog that sings: the miracle is that it does so at all. While a technical feat, usability is never going to be good. To cater to mobile
devices, websites and services should offer much shorter articles, dramatically simplified navigation, and highly selective features, retaining only what’s needed in a mobile setting.”

- High Costs. One of the biggest disadvantages and drawbacks for using a mobile wireless e-learning solution is cost. Recommending m-learning or wireless learning means investing in devices for each learner, paying for wireless service, budgeting for maintenance repair and upgrades, and support from an IT group to answer users’ questions and resolve technical problems. It takes a compelling business case to implement this kind of technology for learning.

POINTS FOR DISCUSSION

We have to contribute to the continued development of mobile learning and to address the imbalance between the availability of mobile devices and the lack of education and training provision on the sophisticated communications devices which every student and actively working person carries and uses constantly – except in education.

We present mlearning as a form of performance support system for educational and training purposes. The advantages for trainees are derived from providing learners with a job aid in the context of their work and more flexibility and choice in where and when they learn outside of the wired (or un-wired) classroom.

Performance-centred approach has been proven to be more effective than the traditional lecture-practice-test (expository inductive) in training higher order skills, for preparing learners for self-learning, improving, adapting for changing jobs. We need to build on previous work in the field – using performance-centred approach in different educational and training contexts, and mobile learning experience, enhance the field of performance-centred education and training by the deployment of state of the art mobile technologies. Wireless mLearning performance support systems are similar to traditional PSS. mLearning solutions integrate mobile devices with the learning to help the student to perform a task by providing information, guidance, and learning experiences when and where they are needed.

The advantages to apply performance support in mLearning to create knowledge are derived from providing learners with a job aid in the context of their learning.

The disadvantages of mLearning are a combination of technical and education challenges. Some of these disadvantages disappear if we apply performance-centred approach to mobile technology enhanced learning. It means that performance-centred method is very appropriate for mLearning pedagogical solutions.

REFERENCES


